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THE BELL-BIRDS OF AMERICA.

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(*With a Coloured Plate.*)

It is only within the last few months that the Zoological Society of London have succeeded in adding to their large collection of living birds examples of the species belonging to the great fruit-eating family of Cotingas (*Cotingidæ*), which plays so conspicuous a part in the ornithology of Tropical America. Birds that in a state of nature subsist almost entirely on ripe fruit are, as might have been naturally expected, difficult creatures to provide for in a state of captivity, especially during the voyage home, and consequently rarely reach our shores alive. Recently, however, several forms belonging to the different frugivorous families of the tropics of both hemispheres have been successfully imported, and amongst them examples of the Cock-of-the-rock of Guiana (*Rapicola crocea*), and the Bell-bird of Brazil (*Chasmorhynchus nudicollis*), two of the most striking members of the above-mentioned family. It is to the latter of these birds and its allied species, which are

alike remarkable for very curious peculiarities in structure and habits, that I now propose to call attention.

The genus *Chasmorhynchus* of naturalists embraces four species of birds, each inhabiting a distinct region of tropical America, of about the same size as the missel-thrush of Europe, but essentially different in structure. Their general form is much the same as that of the typical Cotingas, but they have a more depressed bill and wider gape, and their nostrils placed further forward. The wings are long and pointed, indicating extensive powers of flight. The feet and legs are moderately strong. The tarsi are covered in front with a series of six or seven horny shields; behind with numerous much smaller reticulated scales. The outer and middle toes are united together at their bases to the end of their first phalanx. These two last characters, together with the possession of ten well-developed primaries in the wings, are marked features of the family *Cotingidæ*, to which this genus belongs. But the most special external character which distinguishes the Bell-birds from other genera of the same family is the development in the adult male of naked skin and fleshy wattles in various parts of the head and neck. In all of the known species the adult male is either wholly or partly of a pure snowy white, with more or less of these cutaneous developments, and the female of a dull green above and yellowish below, without any of the peculiar excrescences of the head and neck which distinguish the male sex. Having said thus much about the general features of the genus, I will now say a few words about each of the four known species of this curious group, commencing with the Brazilian *Chasmorhynchus nudicollis*, of which a coloured illustration is given, drawn from the adult male in the Gardens of the Zoological Society.

In the naked-throated or Brazilian Bell-bird, the adult male is wholly of a pure snowy white. The space round the eyes and throat are covered with a naked fleshy skin, which is very sparingly clothed with minute black feathers, only distinguishable on close examination. In the breeding season this naked skin becomes of a fine green colour, which disappears during the rest of the year. The female, as has been already stated, is a very different-looking bird—being of a dull green above, with a blackish head, and yellowish, flammulated with green, below. Nor has she any trace of the naked throat and face which are the characteristics of the male sex.

This Bell-bird was first made known to science by the French naturalist Vieillot,* in 1815, from specimens in the collection of the Jardin des Plantes at Paris. But the best, and, in fact, only good description of it in a state of nature is

* *Nouv. Dict. d'Hist. Nat.*, viii., p. 164.

that given by that excellent and observing naturalist Prince Maximilian of Neuwied, in his *Contributions to the Natural History of Brazil*.* Prince Maximilian tells us that this remarkable bird is one of the most singular features in the fauna of the wooded coast-region of Brazil, and attracts the stranger's notice as well by its brilliant white plumage as by its clear ringing voice. It seems to be very generally distributed through the woods, resorting especially to the thickest and most secluded parts of them. Hence it resulted that the Prince and his party, during their expeditions in the neighbourhood of Rio de Janeiro, became well acquainted with its singular notes some time before they obtained specimens of the producer of them. Prince Maximilian describes these notes as resembling the sound of a clear-ringing bell, sometimes repeated at intervals, sometimes following each other in quick succession. In the latter case they are more like the sound produced by a blacksmith when he strikes a piece of steel upon an anvil, whence the bird has obtained its Portuguese name *Ferreiro* (*smith*†). The song is heard at all hours of the day, and when, as often happens, several of these birds are in the same neighbourhood, and begin singing against and answering each other, a most wonderful vocal concert is the result. The *Araponga*, as this bird is also called in Eastern Brazil, often takes up its station at the highest withered summit of a colossal forest-tree, and pours forth its loud metallic notes out of the reach of gun-shot, at the same time presenting with its lovely white plumage a fine contrast to the clear blue sky. It is, however, easily disturbed by anything unwonted making its appearance. Its food, as ascertained by dissections, appears to be exclusively fruit. Nothing was ascertained by Prince Maximilian respecting its nidification, nor have subsequent observers added to our knowledge on this point.

Of this extraordinary bird a living specimen was first acquired for the aviaries of the Zoological Society of London in May last. It was an adult male, and was purchased from a well-known London dealer in living animals for the sum of £10. Shortly after this bird had arrived in the Society's gardens it commenced its song, and continued to pour forth its peculiar notes at intervals of more or less frequency for several weeks. These notes have been described by an accurate observer in the following manner:—

"The first note is a loud, harsh, and somewhat grating noise; this is followed by six or eight fine, clear, metallic, ringing notes, with an interval of about a second between each of

* *Beiträge zur Naturgeschichte von Brasilien*, 3 vols., Weimar, 1830.

† Professor Burmeister (*Syst. Ueb. d. Thiere Brasiliens*, ii., p. 426) says the Portuguese name is *Ferrador*, not *Ferreiro*, but the meaning is the same.

them. The resemblance of these to the sound of an anvil is most extraordinary. The clear metallic ring, repeated at about the same rate that a blacksmith strikes upon the anvil, is so perfect that many persons upon hearing it are unwilling to believe the sound could be produced by the delicate organs forming the vocal apparatus of so small a bird."

I may add that the bird also makes the most extraordinary gesticulations when producing these sounds. When commencing its song it usually stands upright with its bill aloft, as represented in the coloured plate herewith given. Subsequently it lowers its bill and throws itself violently forward and downward, seeming to assist itself in this manner to pour forth its final notes.

The *Araponga* lost the brilliant green colour of its face and throat at the conclusion of the love-season, and those parts became of a dull grey or lead-colour, as they now remain. Later in the summer a second example of the same species was purchased for the Society. It was a young male, which, as is usually the case with young birds, was clad in the plumage of the female, but is now gradually assuming its adult dress. We are in great hopes, therefore, of having both these birds in full song during the ensuing summer.

In the forests of Cayenne, British Guiana, and Surinam, the *Araponga* is replaced by a second bird of the same genus, the "*Campanero*," or *Chasmorhynchus niveus* of naturalists. In this species the adult male is pure white, as in its Brazilian representative, but there is no deficiency of feathers on the throat, and a long straight caruncle issues from the base of the bill, which at once distinguishes it from the preceding. This curious caruncle in a specimen of a young male in my collection is about three and a half inches long, but is often longer in adults. It is scantily clothed with small feathers throughout. In the breeding-season it is probably carried erect, as figured by Buffon in his *Planches Enluminées*, No. 793, at any rate when the bird is in song. The female has no caruncle, and much resembles the same sex in the preceding species. The Bell-bird of Cayenne was well-known to the older authors, but our best account of its habits is derived from the *Wanderings* of the late Mr. Waterton, who, speaking of the Cotingas, of Demerara, says:—

"The fifth species is the celebrated 'Campanero' of the Spaniards, called 'Dara' by the Indians, and 'Bell-bird' by the English. He is about the size of the jay. His plumage is white as snow. On his forehead rises a spiral tube, nearly three inches long. It is jet black, dotted all over with small white feathers. It has a communication with the palate, and when filled with air looks like a spire; when empty it becomes

pendulous. His note is loud and clear, like the sound of a bell, and may be heard at the distance of three miles. In the midst of these extensive wilds, generally on the dried top of an aged mora, almost out of gun-reach, you will see the *Campanero*. No sound or song from any of the winged inhabitants of the forest, not even the clearly-pronounced 'Whip-poor-Will,' from the goat-sucker, causes such astonishment as the toll of the *Campanero*."

"With many of the feathered race he pays the common tribute of a morning and an evening song; and even when the meridian sun has shut in silence the mouths of almost the whole of animated nature, the *Campanero* still cheers the forest. You hear his toll, and then a pause for a minute, then another toll, and then a pause again, and then a toll, and again a pause. Then he is silent for six or eight minutes and then another toll, and so on. Acteon would stop in the mid chase, Maria would defer her evening song, and Orpheus himself would drop his lute to listen to him; so sweet, so novel, and romantic is the toll of the pretty snow-white *Campanero*. He is never seen to feed with the other Contingas, nor is it known in what part of Guiana he makes his nest."

Proceeding a little further northwards in the forests bordering the northern coast of Venezuela, we meet with a third Bell-bird, the *Chasmorhynchus variegatus*. In this species the adult male has again a white body-plumage; but his wings are black and his head is brown, so that he cannot easily be confounded with either of the former species. His bare throat is sparingly clothed with small black feathers, as in the *Araponga* of Brazil, but besides this there are numerous small fleshy caruncles dependent from the lower part of the throat, which in adult birds attain a considerable length. The female, however, is very like the female of the Brazilian species. This Bell-bird extends along the coast of Venezuela into the forests of Trinidad, where its existence is well known to the colonists.

To find a fourth, and in some respects still more wonderful, species of Bell-bird, we must go further northwards across the isthmus of Panama into Chiriqui and Costa Rica. Here is the abode of the Three-wattled Bell-bird, *Chasmorhynchus tricarunculatus*, the male of which exhibits several very marked differences from those of its three southern congeners. In the first place the head, neck, and breast of this species are alone of the glossy white which is so characteristic of the genus, the whole hinder portion of the body, including the wings and the tail, being of a deep chesnut red. Besides, not content with a single caruncle springing from the base of the bill which distinguishes his brother of Cayenne, the male of this Bell-bird throws out two additional elongated wattles from the

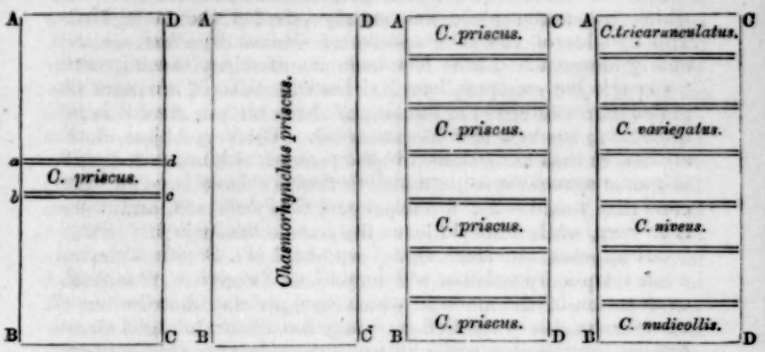
angles of its mouth. These are thinner and narrower than the *Araponga's* single horn, and attain a greater length—the medial caruncle in a young male bird in my collection measuring nearly 4½ inches in length, and extending, when recumbent, down beyond the middle of its back. The female of the Costa-Rican Bell-bird again hardly differs materially from the females of the other species." *

It appears, therefore, that there are four rather widely separated districts in tropical America, each of which is tenanted by a distinct species of this group of birds. The intelligent mind naturally proceeds to inquire why this is so. Why should the Bell-bird of Brazil be different from the Bell-bird of Cayenne, and the Bell-bird of Venezuela from that of Costa Rica? What is the meaning of these four birds, each having a special abode into which the others never intrude? Why are the males of each of them all so different, and the females all four so much alike? Not many years ago it would have been thought rather irreverent to ask such questions as these. We should have been informed in reply, that it was for the same reason that "dogs delight to bark and bite"—because Divine Providence "hath made them so;" and it would be, therefore, no use inquiring into the matter. And this is the theory (if theory it can be called) of the supporters of "special creation" to the present day. They say that each species of organic beings was created to perform certain functions over a definite area, and there is an end of the matter. But it is not easy to satisfy the inquiring spirit of the present age in so summary a manner. Let us try, therefore, if by adopting Mr. Darwin's views of the derivative origin of species and "natural selection," we can invent a theory of any sort which would account for the present state of things as regards the case of these four Bell-birds, and numerous other cases of the same description.

Let us suppose then, that these four Bell-birds, now so distinct, are all descended from a common progenitor—a certain "*Chasmorhynchus priscus*" we will call him. This would at once account for the females of the four species being all alike. Let us suppose that in bygone ages *Chasmorhynchus priscus* lived in a small area (*a*, *b*, *c*, *d*, Fig. 1) occupying the centre of the extended area A, B, C, D. Let A, B, C, D represent the "*generic area*" of *Chasmorhynchus* at the present period, that is the whole of the areas now occupied by the four known species of the genus, together with the intervals between them which are not now tenanted by any species of *Chasmorhynchus*.

* Both sexes of this very singular bird are figured in the *Ibis* for 1865, Pl. iii., where Mr. Salvin has likewise given many interesting remarks on this and the allied forms.

It may be easily imagined that *C. priscus* finding a country suitable to its habits and mode of life, gradually extended its range northwards and southwards, until, instead of its original "*specific area*" (*a*, *b*, *c*, *d*, Fig. 1), it became occupant of the larger area (A, B, C, D, Fig. 2), *i. e.*, the whole of the present "*generic area*" of *Chasmorhynchus*. Now, so long as the area A, B, C, D, remained united and homogeneous it is probable



that, in spite of the innate tendency to perpetual variation, there would be but slight modifications in the structure of our *C. priscus*, as the different varieties would to a certain extent neutralise each other by interbreeding. At all events the changes introduced by progressive variation would be similar or nearly similar over the whole area, and would be such as would, perhaps, enable us to distinguish the extreme northern and southern forms from one another, as is usually the case with species spread over a very extended area, but not of sufficient importance to necessitate the recognition of more than one species.

But now let us suppose that the slow course of secular variation which is constantly altering every part of the surface of our globe, operates upon the area A, B, C, D, where the vacant intervals are placed in Fig. 3, and renders these portions unfit for the habitation of *C. priscus*. This might take place either by the submergence of the vacant tracts, and division of the extended area into four islands, or by their elevation, or simply by the failure of certain trees on the fruit of which *Chasmorhynchus* subsists within the vacant areas. *Chasmorhynchus priscus* would, after this event took place, occupy four different areas, completely cut off from one another, as shown in Fig. 3. The tendency to variation would now act

upon the individuals located in each of these four separate areas in a different manner, according to the different natural influences (such as food, weather, climate, etc.) affecting them. Communication being cut off between them, there would be no neutralization of the variation occurring in one area by a contrary variation occurring in the adjoining area. The four isolated colonies of our *C. priscus* would therefore, in process of time, become a series of four distinct species, as represented in Fig. 4.

It will be remarked in the present case that the variation which has taken place has mainly affected the male birds. The females of the four species of *Chasmorhynchus* are still nearly identical. There has been manifestly a much greater "*struggle for existence*," as Mr. Darwin calls it, amongst the males than amongst the females of these birds. And it is not difficult to see how this has occurred. The very object of the structures that have altered in the present instance is to render the male agreeable to its mate, so that we have here an influence that would work forcibly upon the male sex, and cause it to vary, while it would leave the female untouched.

It appears, therefore, that if we adopt Mr. Darwin's theory, a few simple hypotheses will enable us to give a reasonable explanation of the mode in which the present distribution of the four species of the Bell-bird may have been brought about. Similar hypotheses will explain hundreds and thousands of other cases in which groups of animals and plants offer corresponding phenomena as to their geographical distribution. What the exact influences were that divided up the area formerly occupied by the common progenitor of the four *Chasmorhynchi*, it would be impossible at present to say; but it will be seen at once that when the geological structure of the earth is more perfectly known, great light will necessarily be thrown on problems of this nature. Such problems, in our present state of ignorance of the formation of the greater part of the earth's surface, it would be vain to attempt to answer in a decisive way. But it seems better, even under present circumstances, to attempt some sort of explanation of these and similar phenomena, than to remain content with the *deus-ex-machinâ* theory of "special creation," which is in fact no theory at all, but only a periphrastic way of confessing our ignorance of the subject.

PARASITIC BEETLES.

BY E. C. RYE.

Our *Coleoptera*, or beetles, exhibit none of those pre-eminently social or constructive instincts which have attracted the earliest exercise of human observation to certain of the *Hymenoptera* (bees, ants, etc.). It is true that in some cases their habits are gregarious; but their associations are for the most part apparently devoid of purpose, beyond the procuring of food, and are usually to be accounted for on the most easily intelligible grounds, such as (in the case of the *Phytophaga*) the occurrence of their food-plant in isolated spots, or the incapability of much motion attendant upon the structure of the larvæ of many species, which usually causes the produce of one batch of eggs not to get dispersed until they arrive at the perfect state. Their labours, also, which seem never (except in the case of certain *Necrophori*, commonly known as "burying-bettles") to be undertaken in concert, are limited in their earlier stages to the construction of the most rudimentary hybernacula, cells, galleries, or pits, or to the erection of protective cases (*Clythra*, *Cryptocephalus*)—in all of which operations they exhibit less ability than the caterpillars of the more lowly organized order *Lepidoptera*, and, in their perfect state, to the exercise of the most ordinary instincts for the protection of their future offspring; such protection being in the majority of instances confined to depositing the eggs in convenient and proper situations, though some species, such as the above-mentioned burying-beetles, certain of the *Rhynchophora* (*Rhynchites*, *Pissodes*, *Balaninus*, etc.), and some of the indigenous Coprophagous representatives of the sacred-beetle of the Egyptians, exhibit considerable ingenuity, and are compelled to use much physical force, in their preparations for the welfare of their descendants.

There remain, however, certain (as it were, morganatic) alliances constantly contracted by beetles with other insects, for which as yet no satisfactory explanation has been given; and it is to these that the present paper refers. There are even some associations of *Coleoptera* with animals out of their own class, such as that of *Haploglossa nidicola* (one of the *Aleocharidæ*, a large family of small *Brachelytra*, of which section the common "Devil's coach-horse," *Ocypus olens*, is the most gigantic and the best known exponent) with the sand-martin, and *Drilus flavescens* with certain species of *Helix*; but these and their like are readily capable of interpretation. The former insect, which has received its specific name from its nest-hunting propensities, is a parasite upon the bird for

the sake of its droppings, and possibly for such crumbs as fall from its table. I am not aware whether the sand-martin employs much (if any) dried twigs, grass, or leaves as a pad at the bottom of its burrow; if such be the case, however, it would be of use in assisting to solve the question of the alliance between bird and beetle, as another of the latter's genus, *Haploglossa prætexta*, sometimes swarms in twigs, etc., at the bottom of neglected hay-stacks. Another of its intimate allies, *Haploglossa gentilis* (hereafter mentioned), is a parasite upon ants; so that sycophancy seems to run in the family. *H. nidicola*, being very small, is doubtless in some of its stages unwittingly transported by the birds from one nest to another; I have never heard, however, of its being found in the nests of any bird but the sand-martin, under banks perforated by which it may be found in profusion. The nests of birds, on account of their warmth, damp, etc., often serve as a home for beetles, which in many cases may be originally introduced with the substances of which they are built. A curious instance of this, and somewhat entomologically akin to the accounts so often to be read in provincial journals of birds building in unusual or much frequented situations, is to be found in the capture by Mr. E. Waterhouse of several specimens of the rare *Dendrophilus punctatus* in sparrow's-nest rubbish stuck in a water-pipe of the British Museum. Another species of *Dendrophilus* (*D. pygmæus*) is a true ant-parasite, and *D. punctatus* has itself been taken in nests of *Formica rufa*; so that the parallel between it and *Haploglossa* is, oddly enough, somewhat close.

Drilus flavescens is constantly found in the vicinity of snails (*Helix nemoralis*, etc.), for the simple reason that its larva feeds upon those molluscs. It is, however, noteworthy on account of the males only being known in this country (in certain chalky parts of which, near Dover, Dartford, etc., it is not uncommon); but the non-appearance of the other sex is not due to the same cause (whatever it may be) as that which baffles us in the endeavour to discover the males of certain abundant species of *Cynips* (gall-insects). In the latter case persistent but unsuccessful endeavours have been made (by breeding, etc.) to solve the enigma; but, as to the *Drilus*, failure is owing simply to a want of sufficient experiment: for if any one assiduously collected snails in the localities where the male occurs, the female would assuredly be detected, as I have found the full-grown female larva at the base of Shakespeare's Cliff, running very quickly among empty snail-shells in the hot sunshine. The two sexes—as in the glow-worm (*Lampyris noctiluca*), to which it is closely allied, and which is equally rapacious and mollusc-devouring, *malgré* its poetical reputation—are very dissimilar in appearance; the male having wings and brown

elytra, with conspicuous and strongly pectinated black antennæ, and the female being apterous and slug-shaped, having, indeed, been described as belonging to a separate genus, *Cochlæoctonus*, founded upon it, and named in allusion to its habits. As also in the glow-worm, the resemblance between the perfect female and full-grown female larva is considerable.

The ordinary associations of beetles with other insects are purely for the purposes of preying upon them or their leavings; but some few are sufficiently interesting to be noticed. The most frequent and unvarying alliances of this class are, perhaps, those of certain of the *Nitidulidæ* (*e.g.*, *Epuræa* 10-*guttata*, *Soronia grisea* and *S. punctatissima*, *Cryptarcha strigata* and *C. imperialis*, and, I suspect, the very rare *Thalycra sericea*) and *Aleocharidæ* (*Homalota cinnamomea* and *H. hospita*) with the goat-moth (*Cossus ligniperda*); in and about the burrows made in the solid wood by the large naked red fleshy larva of which insect most of them may be readily found, and sometimes in profusion—no matter in what tree, be it oak, elm, willow, or poplar, the Lepidopterous devastator may be ploughing its deep tracks. The exudation of sap and quantities of wet woody excrement, caused and left behind by this caterpillar, strongly impregnated, moreover, with its peculiarly rancid odour, seem to act as a never-failing attraction to the above-mentioned beetles (as the collector well knows), and to many others; amongst them being the very rare *Quedius dilatatus*, a large black *Brachelytron*, formerly only known to occur in the nests of the common hornet (*Vespa crabro*), under the protection of whose sting (by what means diverted from itself we cannot tell) it may readily be believed that it was safe from capture. M. Chevrolat, a distinguished French entomologist, has, however, recently detected it haunting the burrows of the goat-moth larva, coursing rapidly in and out of the galleries by night; and it has since his discovery been taken under similar circumstances in this country. There can be little doubt, from the habits of certain other *Quedii* (*Q. lævigatus*, *cruentus*, *xanthopus*, *scitus*, *longicornis*, and *truncicola*) frequenting trees, that this beetle merely exhibits a preference for such localities in consequence of the number of other insects also attracted to them, upon which it preys.

Many other beetles also found under or about bark are predaceously parasitic upon insects either of their own or another order. Of these, *Ips* and *Rhizophagus*, attendant upon the genuine wood-feeders, *Hylesinus*, *Hylastes*, and *Hylurgus* (as mentioned in No. LVI., p. 133), are notable examples; and with them may be classed two very rare species, *Nemosoma elongata*, one of the *Trogositidæ*, and *Colydium elongatum*, the type of the *Colydiadæ*, both of which are of an elongate tere-

brant form, and have hitherto been considered as true wood-feeders; but the former is a parasite upon some of the genuine *Xylophaga*, and the latter preys upon *Platypus cylindrus*, to whose attenuate shape it bears some resemblance. *Opilus* and *Clerus*, predaceous Malacoderms, follow *Anobium* and other dry-wood eaters, upon the larvæ of which their larvæ feed: *Anthribus* and its allies, sedate and massive, and, on account of their belonging to the peaceful section of *Rhynchophora*, long unsuspected of such appetites, are now known to prey in their larval condition upon *Coccus;* a habit for which fruit-growers would doubtless thank them; the beetles are, however, so exceedingly rare here that no practical good can result from their operations. Of a similar class to these relations is the companionship of *Dyschirius* with *Bledius*, members of which two genera are constantly found together—often in profusion—burrowing in sandy places on our coasts and elsewhere. Both are of elongate and cylindrical shape, eminently adapted for their sphere of existence; *Dyschirius* (the wolf) being clothed with more continuous and solid armour, and possessing two very strongly arched, thickened and spined front legs, eminently fitted for fossorial purposes, and representing the structure of the fore paws of the mole; and *Bledius* (the lamb) having a flexible and somewhat loosely articulated body, and often (in the male) acute, stout, projecting horns on the head and thorax, doubtless also of service in digging.

Another—and the largest reputed British—member of the *Geodephaga* (to which section *Dyschirius* also belongs), *Calosoma sycophanta*, has received its specific name from its parasitic connection with the gregarious larva of the processionary moth (*Cnethocampa processionea*), upon which it gorges its fill, both in its own larval condition and as a perfect beetle. It is an exceedingly handsome and large insect, being of a violet-black colour with golden, green, and coppery reflexions, and has for a long time stood its ground in our lists of indigenous species (of which, from mere beauty's sake, it forms one of the chief glories) on the strength of its periodical occurrence, chiefly on or near the coast-line. There seems little doubt, nevertheless, that it is merely an accidental visitor from some of the continental districts where it abounds; as its especial pabulum, the processionary caterpillar, is not found at all in England, and the beetle is not only possessed of stout wings, and, from its strong build, evidently capable of considerable exertion, but has even been taken actually floating on the sea near our shores, suggesting the idea of its dropping nearly exhausted after a long flight.

The numerous recorded instances of butterflies and other equally delicately organized insects being seen at greater

distances from land than the *Calosoma* would have to travel, quite warrants this supposition. We have, however, another undoubtedly British species, *Calosoma inquisitor*, of smaller size and less beauty, which constantly frequents oaks for the purpose of promiscuous feeding on the many Lepidopterous larvæ frequenting those trees. This habit of tree-haunting is very rare among the large and predaceous *Carabidæ*, which usually prowl about on the ground, except occasionally at night, when they have been observed investigating tree trunks for their victims. Another of the *Geodephaga*, *Zabrus gibbus*, a large, heavy, clumsy, black species, departs from the habits of the members of that group so far as to be often seen climbing up the shoots of young wheat and other plants. This has been so frequently observed that it has been strenuously urged that the beetle, unlike all its sectional allies, is a vegetable feeder; but the more reasonable view appears to be that it frequents the plants for the purpose of preying upon the numerous small insects of all orders found upon them. A similar explanation accounts for the constant occurrence of one of the burying-beetles, *Silpha quadripunctata*, upon young oak-trees, where it finds a ready meal on plant-feeding larvæ. I have never found this insect in any other place than upon an oak-tree; though the other *Silphæ* (except, perhaps, *S. atrata*) constantly occur in carrion.

All the above cases of companionship, therefore, readily admit of explanation, as also do certain of those hereafter mentioned, of some of which the entire life-history has, indeed, been accurately chronicled.

It will be observed that, in all the following instances, the insects with which the beetles are associated belong to the order *Hymenoptera*; and it is in connection with the social members of this order that the most constant and perfect—though hitherto unexplained—cases of beetle-parasitism occur.

The bees, to begin with, are affected by species of at least three different genera, viz., *Trichodes*, *Melöe*, and *Sitaris*.

The first of these, one of the *Cleridæ*, has two reputed British exponents, *T. apiarius* and *T. alvearius*, whose names sufficiently indicate their propensities. Both of them are, however, of exceedingly doubtful British origin, though abundant on the continent; they are of moderate size, elongate, bright blue with red bands, and very pubescent. *T. apiorius* lives in its larval condition in the combs of the honey-bee (*Apis mellifica*); whilst *T. alvearius* at a similar stage of its existence inhabits the nests of mason-bees (*Megachile muraria*, and others), though it has also been found under pine bark. Both of them feed upon the larvæ of the legitimate owners of their temporary residences, and, in their perfect

state, are found in flowers, where it is possible that they may deposit their eggs, which would be readily (inadvertently) carried to their nests by the visiting bees.

Melöe comprises the well-known "Oil-beetles"—huge, clumsy, wingless, fat, blue-black insects, with short overlapping sytra, and of feeble development—frequently seen crawling heavily in early spring on commons and waste lands, especially among butter-cups, and conspicuous for their nasty peculiarity of exuding a clear yellow oil from their joints when handled, which has in bygone times (with many more nauseous remedies) been in favour for the purposes of medicine. The female deposits separate batches of small yellow ova, thousands at a time, but on a diminishing scale after the first laying. These ova are agglutinated, and dropped into small holes in the ground previously dug by her; and from them, after a period of from three to six weeks, as the heat of the weather varies, the young larvæ are hatched, being then long, flat, yellow, with longish legs and four hairs at their hinder apex, resembling, in short, small bird-lice. For a time they keep torpid; but, on being sufficiently roused by increased warmth, course about certain low plants (chiefly *Ranunculaceæ*) with wonderful rapidity of motion. From these plants they fasten, sometimes in great quantities, on the hairy bees that are busy about the flowers: at times, also, getting attached in error to some equally hairy species of *Volucella* (Dipterous insects superficially much resembling bees), that also settle on their temporary lodgings. Of course, in the latter case, the attachment is not a lucky one for the parasite: as the fly makes no nest to which it can be transported, and it must perforce starve. It is probably the chance of this, added to the numerous lucky combinations that *must* take place before the *Melöe* larvæ can reach its destined haven, that causes the parent beetle to deposit so large a number of ova; and there can be no doubt that the produce of one female would, if it all came to maturity, outnumber vastly all the perfect insects that would be seen by any one observer in his lifetime.

Supposing that the larva has been carried by the unconscious bee to its nest, it devours the egg of the latter therein contained, and changes into a second form (not unlike the larva of a small Lamellicorn beetle, being cylindrical, arched, and possessing stout legs and toothed mandibles), subsisting on the food laid up by the bee for its own young. After some time the second condition of the larva changes its outer skin, which is not, however, entirely shed, but remains wrinkled up at the hinder extremity of the body; it is then arched, composed of thirteen segments, contracted at each end, and motionless. This is called the *false pupa*, and from it (pro-

bably after a winter's interval) a third form of the larva appears, similar to the second. Here, however, ceases all direct record of the extraordinary metamorphoses of this insect; the most unaccountable part, viz., the passage of the heavy, full-grown, bloated beetles from the bees' nest to the commons where they are usually found, not having been hitherto observed.

The transformations, however, of *Sitaris muralis*, the third above-mentioned bee-parasite, throw some light upon the final changes of its ally *Melöe*. This insect, which, unlike the latter, has ample wings, though its elytra are of imperfect development, is, during all its existence, parasitic upon mason-bees of the genus *Anthophora*, which are common in old brick-walls. Here the larvæ undergo fewer vicissitudes than those of *Melöe*, as the eggs are deposited by the parent at the entrance of the bees' burrow, near which it stays; and the young larvæ, after passing through the above-mentioned stages, and taking no food in their third condition, change to the ordinary Coleopterous pupa, from which the imago is produced after about a month's interval; the whole metamorphoses covering a space of about two years.

Mr. Newport has given particulars of his discoveries as to this species in the *Linnæan Transactions*, vol. xx., p. 297, and vol. xxi., p. 167. M. Fabre, also, in his "Mémoire sur l'Hypermétamorphose et les mœurs des Méloïdes," in the *Annales des Sciences Naturelles*, sér. 4, vol. vii., 1857, p. 299, goes into considerable detail with reference to the abnormal nature of the above-mentioned changes.

In connection with these beetles, mention must be made of certain interesting insects variously considered as a separate order, under the name of *Strepsiptera*, or simply as a family of the *Coleoptera*, under the name *Stylopides*. As there exist strong reasons to suppose that the latter view is incorrect, and as the details of their structure and habits are too voluminous and interesting to be hurried over in a paper of this kind, it may be sufficient to remark that they are parasites chiefly upon the females of certain *Andrenidæ*, a family of wild bees; the female *Stylops* remaining enclosed between the abdominal rings of the *Andræna* during all her stages, and the male until his perfect condition; when he acquires wings, exhibits great activity in his search for the other sex (which is, of course, carried about in its living prison), and dies within a day of arriving at maturity. Our countryman, Kirby, was the discoverer of these marvellous insects.

Of other—and undoubtedly Coleopterous—bee-parasites, *Leptinus testaceus*, a species of considerable rarity in this country (I once found it in a nest of the large black wood-ant, *Formica*

fuliginosa, at Mickleham), has recently been detected on the continent, living in the nests of one of the larger white-tailed humble-bees (probably *Bombus terrestris*). Herr Eichhoff, who records this occurrence, states that there were but two or three nests in which he did not find the beetle, out of thirty that he examined, and that some contained twenty or thirty specimens each; there can, therefore, be little doubt that the true residence of this interesting Acaroid little creature has been now discovered. Other beetles, also occurring (though comparatively rarely) in this country, have been observed on the continent to be parasites upon humble-bees, such as *Cryptophagus setulosus* (in great plenty) and *C. pubescens*, *Antherophagus nigricornis*, *silaceus*, *and pallens*.

Nor are the dwellings of the allied genus *Vespa* without their illegitimate tenants. The hornet (*V. Crabro*) fosters (or is compelled to tolerate, whichever be the true interpretation) *Quedius dilatatus*, as above-mentioned; and the common wasp (*V. vulgaris*), apart from *Cryptophagus pubescens* (which has been observed on the continent to be more abundant with it than with the humble-bees) and, occasionally, *Onthophilus* (one of the true Coprophagous *Histeridæ*), lodges in its structures a most curious beetle, *Rhipiphorus paradoxus*, one of the *Mordellidæ*, in which the body is broadest and convex on the upper side, but shelves down to a mere ridge beneath, and a certain degradation in the development of the parts of the mouth commences. This insect undergoes its transformations in the cells of the nests, the larger larvæ (from which the females are produced) being found with, and feeding on, the female wasp grubs. The perfect insect, which is also sometimes found in the nests, varies considerably in the two sexes, the female being the largest and usually having blue-black elytra, which are of imperfect development, being attenuated and gaping, so as to allow the wings to be seen. In the male the elytra are reddish testaceous, and the antennæ have the third and following joints divided into double fan-like rays. It will be remarked that the parasitic habits of this insect, as in *Melöe* and *Sitaris* above-mentioned, are accompanied by a lessening of the usual development of certain parts of the body. Our countryman Mr. S. Stone has accurately observed the economy of these parasites on the *Hymenoptera*.

Lastly remain to be noticed the most interesting of all the alliances of the *Coleoptera*, viz., those with the ants. So numerous and constant are these alliances that the epithet "*Myrmecophila*" has been coined to express the beetles that contract them; and they have formed objects of study to eminent entomologists in all European countries, Aubé, Chevrolat, Grimm, Janson, Kiesenwetter, Mœrkel, Mannerheim,

Motschulsky, and Schiödte being conspicuous among them. In spite, however, of the numerous observations that have been made, and of the extension among British Coleopterists of acquaintance with these beetle-ant connections through collecting operations, no satisfactory explanation has been given for them. It has, indeed, been suggested that the *Coleoptera*, and especially those of the section *Brachelytra*, resorting to the nests may be in some way conducive to the welfare of the communities, in all probability yielding secretions which serve as food to the young brood. But this view appears to me to reverse the case. It is surely more likely that the beetles find in the secretions of the ants or in the materials of which they form their nests, or in the food which they procure for their young brood, a sufficient attraction to induce them, as free agents, to take up their abode with the latter. On the other hand, in two instances, at least, viz., *Claviger testaceus* and *Atemeles*, there can be no doubt that their landlords are as careful over them as their own young, bearing them rapidly, but with an excess of care, away from the approach of danger, and exhibiting as much anxiety on their account as some of their species do for the *Aphides*, to whose secretions, so agreeable to the ants, it is possible that those of the beetles may be similar. It is certain that the larger *Brachelytra* frequenting ants' nests acquire a most peculiar and pungent odour, and that they often distil an iodine-coloured fluid on the cards on which they are mounted, and retain a like smell for a considerable period. This, evidently (from its similarity of smell) derived from constantly dwelling in a vapour of exhalations of formic acid, may, on the principle of "similia similibus," be acceptable to the ants, whose ingenuity may succeed in "tapping" the internal supply, though there is no visible outlet as in the *Aphides*. Apart from this interpretation, there remains no solution for the enigma but that of sentimental attachment, which is rather too absurd for such work-a-day folk as the *Formicidæ*. No verbal expression could, nevertheless, sufficiently depict the evident trouble and anxiety with which a *Formica fusca* carries away *Atemeles emarginatus* in its jaws, tenderly bearing it; and there is something ludicrous in the complacency of the beetle, a great, angular Brachelytron, as it submits to be thus dandled; the absurdity of the thing being more apparent when one compels the ant to drop its nurseling, which straightway opens out its long legs and antennæ, and, considerably larger than its late porter, scuttles away with straggling gait.

The British ants which have hitherto been observed to harbour beetles in their nests are *Formica rufa*, *F. congerens*, *F. fusca*, *F. fuliginosa*, *F. flava*, *F. sanguinea*, and *Myrmica rubra*.

The first of these, *F. rufa*, commonly known as the wood-, hill-, or horse-ant, is of large size and red colour, with darker abdomen; it builds heaped up nests of a conical shape, composed of twigs or any light rubbish not too bulky for transportation. Sometimes these nests, when undisturbed, are quite two feet high; and they are often constructed inside the trunks of hollow trees or piled up against the outsides. The cells appear to be formed in the ground, and the heap acts merely as a shelter.

Associated with this ant—which is a most pertinacious, pungent, and pugnacious creature, holding on by its mandibles, and allowing its body to be torn away, leaving the head and jaws attached, rather than relinquish its bite; and which, moreover, has a pleasing habit of bringing its abdomen forward between its hind-legs, and therefrom projecting an acrid juice to some distance—are found some twenty species of beetles in this country, the majority belonging to the *Brachelytra*. Of these, perhaps, the most typical is *Myrmedonia humeralis*, belonging to the genus of myrmecophilous beetles *par excellence*, as all its members are either positively or by reputation ant-parasites, one of them, indeed, *M. canaliculata*, being found with nearly all ants, though also in other situations. The two exceptions are *M. Haworthi* and *M. collaris*, both considered myrmecophilous, but I think erroneously; the former is so rare both here and abroad that there is no sufficient evidence of its true habitat, all that have been found having occurred in sandpits or among dead leaves; and the latter is certainly a wet-moss insect, occurring in the Norfolk Fens and on Wimbledon Common in *Sphagnum*. Our countryman, J. F. Stephens, who first described the former of them, separated them both from *Myrmedonia*, and formed two separate genera (not now recognized) on their behalf. It is somewhat amusing to notice the revolutions that take place in a few years both in nomenclature and collections. At the time of publication of that author's manual, the secret of ant's nest hunting was either not known or not appreciated in England; the result being that the claim of divers species (now in every novice's cabinet) to a place in our lists depended upon single specimens, found "under a stone," or "flying," or under similar accidental circumstances.

In the nests of *F. rufa* are also found the following *Brachelytra*:—*Thiasophila angulata* (and sometimes *T. inquilina*), *Dinarda Mærkelii* (a small form of which occurs also with *F. sanguinea*), the exceedingly rare *Lomechusa strumosa*, *Oxypoda formiceticola* and *O. hæmorrhoa*, *Homalota anceps* and *H. flavipes*, *Quedius brevis* (some of whose congeners are above-mentioned as either direct or indirect parasites on other insects), *Lepta-*

cinus formicetorum and *Xantholinus ochraceus* (which, though found in the nests, is probably not truly attached to the ants). Of the *Histeridæ*, *Saprinus piceus* and *Dendrophilus pygmæus* (and perhaps *D. punctatus*); and, of the *Colydiadæ*, *Monotoma conicicollis* and *M. angusticollis* frequent these nests, where also the larvæ of the common rose-chafer, *Cetonia aurata*, occasionally live, and those of *Clythra 4-punctata* seem to have their natural habitat, though the perfect insects of both these species would never be suspected of such an origin. Another unsuspected visitor is the rare and delicate *Prionocyphon serricornis*, which has, on more than one occasion, been taken in these nests.

In the nests of *Formica congerens*, a species closely allied to *F. rufa*, and occurring in Perthshire, the larva of *Cetonia cænea* has its dwelling; the perfect beetle having been observed to fly down and disappear, burrowing in the huge mounds of nests until it reaches a place judged fit for the deposit of its eggs. Here also is found the little *Homalota parallela*.

With *Formica fusca* cohabit *Atemeles paradoxus* and *A. emarginatus*, *Dinarda dentata*, and the quaint pigmy *Hetærius sesquicornis*, with uni-articulate club to its antennæ. The nests of this ant are very unlike those of the preceding, being merely cells connected by intricate passages and galleries, excavated beneath the surface of light warm banks, and usually having their entrance under a stone. The *Hetærius* seems to be an object of great care to the ants. Near the nests of this species (and also with *F. rufa*) the large and handsome *Aleochara ruficornis* has been captured. *Homœusa acuminata* was, also, first introduced as British on the authority of a specimen taken in a nest of *F. fusca*; but subsequent investigation has shown, that its true haunts are the runs or beaten paths worn by the thin lines of scouts ever on the tramp near nests of *F. fuliginosa*, a large jet-black ant usually building in decaying trees, from and to holes near the roots of which hundreds of its shining workers may be seen constantly hurrying.

With the latter *Myrmedonia humeralis* and *Quedius brevis*, at times so abundantly associated with *Formica rufa*, are very rarely found; but other *Myrmedoniæ* in plenty supply their place, no less than five species of that genus (*funesta*, *laticollis*, *lugens*, *cognata*, and *limbata*) evincing a partiality for the chewed woody fibres ejected from their galleries by the ants, and deposited near the mouths of the burrows in moist fermenting heaps. The first of these beetles, *M. funesta*, is often exceedingly abundant, running about rapidly amongst the troops of its friends, from which, on account of its similar stature, equally shining mail, and deep black colour, it is not readily to be distinguished. All these *Myrmedoniæ* have a

curious habit of packing themselves up when not in motion; the head being deflected, the abdomen rolled up over the thorax and elytra, and the antennæ and legs cramped together; so that, when they suddenly stretch their body and limbs to their fullest extent, the difference in size is very conspicuous. They also readily counterfeit death; and scamper off with marvellous celerity on the approach of danger. Many other *Brachelytra* are found in *fuliginosa* nests; *Haploglossa gentilis*, *Oxypoda vittata*, *Homalota confusa*, *Thiasophila inquilina*, *Omalium pygmæum*, and *Falagria thoracica* (the latter, however, being often seen in other situations) constantly occurring in them, with beetles of other sections, such as *Amphotis marginata*, *Batrisus venustus*, *Abræus globosus*, *Atomaria ferruginea*, etc. I have taken the rare *Leptinus* (above mentioned as a *Bombus*-parasite) with this ant; and the very rare *Oxylæmus variolosus* has been recorded on the continent as also dwelling in its nests. This is not unlikely to be the case, as I have found *Cicones variegatus*, one of its close allies, in the sodden wood-dust at the mouth of the burrow; but in both these instances it is probable that the visits are only accidental, for *Cryptophagus scanicus*, and other certainly non-myrmecophilous species, may be often found in these places. In the runs near the nests above alluded to, and which are from time to time changed by the ants, a new and conspicuous species of *Oxypoda* (*O. glabriventris*, mihi) has recently been discovered at Mickleham.

The little yellow ant, *Formica flava*, abundant all over the country, appears, in the construction of its nests, to adapt itself to circumstances; for in woods or green meadows it raises little mounds to keep the rain away from its cells, having, indeed, been remarked to utilize mole-heaps for this purpose; but in hilly or chalky districts it simply constructs passages and cells under large stones. These latter are the residences of that most curious little yellow beetle, *Claviger testaceus*, which, on account of its want of eyes, and otherwise general debasement of structure, is usually placed at the end of the *Coleoptera*, being the opposite extreme to the highly organized *Cicindelidæ*, or tiger-beetles. There can be no doubt, from the number of times that *Formica flava* has been observed to evince the greatest care over this beetle, hurrying it away to the inmost recesses of the burrows, on the surface stone being lifted, that it is an object of importance to the community; for to suppose that the somewhat similar appearance of beetle and ant in size and colour deludes the latter into taking these precautions, under the supposition of the *Claviger* being one of the family, is not only an insult to its intelligence, but is not warranted by usual practice, for the ants only carry away their

larva or pupæ, which are of a different shape and hue to themselves. With this ant *Myrmedonia limbata* and the rare *Trichonyx Mœrkelii* also occur sometimes.

From the above account it will be seen that the bond of persistent connection between certain *Coleoptera* (chiefly of the section *Brachelytra*) with some of the Heterogynous *Hymenoptera* remains yet to be fully explained; and rural observers of insect economy, who desire a change from the study of the habits of the honey-bee, will find a new field in the endeavour to supply this explanation.

BUDDHISM AND ITS LEGENDS.*

A religion which at the present day represents the feelings and guides the thoughts of at least three hundred millions of the human race, which had its origin some centuries before the Christian era, and which is more or less associated with the highest existing forms of Oriental civilization, is, of necessity, a very remarkable object of contemplation; and there are peculiarities about Buddhism which make the extent of its diffusion an almost unique phenomenon. From the stationary tendencies of Eastern life, we can imagine that any set of opinions once adopted would be tenaciously preserved; and, had it not been for occasional extensive conquests, the Oriental mind could have had few tendencies to change impressed upon it for a long series of generations. The causes why the civilization of Oriental nations ceased to be progressive are no doubt complicated; but, if we look to the way in which society progresses in Europe, we may arrive at the conclusion that no people continue to advance except they are stimulated by contact and competition with other people equal with, or superior to, themselves in some important particulars of knowledge, aptitude, or skill.

In former ages there was more vitality in the East, and, about six hundred years before our era, in the days of the Prophet Daniel, Mr. Spence Hardy invites us to imagine ourselves "in an appanage of Rajagaha, the capital of Mágadha, where the lord paramount of the Aryan race holds his court." He pictures the intellectual culture as resembling that of Athens in the days of its earlier philosophers; the commercial activity well developed, and "a freedom of manners and constancy of intercourse between the different grades of society

* *The Legends and Theories of the Buddhists compared with History and Science.* With introductory notices of the Life and System of Gotama Buddha. By R. Spence Hardy, Hon. M.R.A.S. Williams and Norgate.

like that seen now among the nations of Europe." "A general opinion seems to prevail that some great personage is about to appear, who will make all one, from being gifted with unerring intelligence and unbounded power . . . and men are waiting for some event to decide whether future ages are to be ruled by a Chakrawartti, a universal monarch, or guided by a Buddha, or all-wise sage."

On Sunday, the day of the full moon in the month of May, and in the year B.C. 623,* a prince of the house of Sákya was born in Kapilawastu, a city supposed to have been on the borders of Nepaul, and on the following day his mother died. As he grew up, his preceptors foretold that he would become a recluse, and his father endeavoured to entice him into a more regal mode of living by the pleasures of the chase and the glories of war. At the age of sixteen he was married to the princess Yasodhora, "peerless in excellence and in grace"; but his character seems to have had few capacities for domestic enjoyment. The sight of a leper, and afterwards of a decomposing corpse, encouraged his brooding and introspective propensities. He came to the conclusion that all existence was vanity, and he determined to exchange his princely rank, with all its luxuries, for the position of a wandering mendicant, carrying an alms-bowl to receive the gifts of the charitable. He put this intention into practice on the very day on which his wife presented to him his first-born child. He looked at the infant and its sleeping mother, felt no compunction at leaving them, and rushed off into the forest with an attendant, whom he soon dismissed.

When he carried his beggars' alms-bowl through the town, the beauty of his person and the grace of his manner caused many to take him for a celestial personage. He accepted the morsels of food that were given to him, and eat them under a tree; their uncleanness reminding him of the vileness of man's body. His austerities nearly cost him his life, but he recovered, and spent six years in mental anguish and ineffectual search for absolute truth, and the means of extinguishing all human desire. Again he carried the alms-bowl, and, being deserted by his companions, continued his struggle alone. "Taking with him," says Mr. Spence Hardy, in his graphic narrative, "as much food as would support him during forty days of additional trial, he retired to the spot that was afterwards to become of world-wide renown. There, under a bo-tree, he was assaulted by innumerable demons, and the contest was fiercely

* The dates of Gotama's birth and death are variously given; the latter being, according to some authorities, 2422 years B.C., others place it at 544 B.C., and Westergaard as late as 370 to 368 B.C. Spence Hardy is a high authority on all questions of Buddhism, and we give his in the text.

prolonged; but he resisted with like success the menaces of frightful fiends and the allurements of beauty, under all the forms that licentiousness could devise, until, before the setting of the sun, he was the acknowledged victor; and, before the light had again dawned, the great end of his toil was accomplished, and he stood forth before all worlds a supreme Buddha, 'wiser than the wisest, and higher than the highest.'"

His first intention was to keep his newly-acquired wisdom to himself, but, on second thoughts, he resolved to commence preaching the Dharmma, unfolding the principles of his religion. Five Brahmins, who had been the associate of his first ascetic wanderings, were chosen as his first hearers and disciples. He taught them that sorrow is connected with every mode of existence, and that its cause is desire or attachment to sensuous objects, from which, by right conduct and mental tranquility, man may be relieved. Perfect freedom from desire would constitute the nirwana, or state of final perfection.

The King of Mágadha became a convert "on hearing the stanza so often found in monuments" now existing in India, "All things proceed from some cause: this cause has been declared by the Tathágato: all things will cease to exist: this is that which is declared by the great Sramana (Buddha)." It is, perhaps, impossible for any member of the modern Western world to understand how such maxims or dogmas could be accepted as the results of a supernatural exaltation to the highest medium, or how the metaphysical system of the ascetic sage could so readily obtain its marvellous sway. Mr. Spence Hardy considers that, at the period when the new religion was introduced, the popular theology was in a transition state between the Vedantic and the Brahminical systems, but with a tendency towards the latter, which developed its cumbrous mythology at a later date. In times when wealth and power are concentrated in few hands, an ascetic religion is sure to exercise a fascination over those who are hopelessly shut out from luxurious enjoyments, and it also comes as a relief and contrast, needed by those who repent of licentiousness when they are satiated and nauseated with its evanescent delights. The power of self-renunciation for a good object must likewise, in all stages of society, exercise a charm over the human mind, and Sákya-Muni, the "Penitent," must have appeared, in the eyes of his followers, elevated far above the earthly dignities which he abandoned in his resolute and arduous, though misguided pursuit of truth.

Were any one now to profess to be "wiser than the wisest," his pretensions would be tested according to the positive methods of physical science; but pre-scientific times were of necessity times of credulity, in which there were no means

of disproving the most preposterous assertions, and when the world was prepared to accept teachers more from the vigour of their egotistical assertions, than from the evidence they might adduce. We may suppose Sákya-Muni to have come as a religious reformer, opposing certain growing and mischievous errors of Brahminism, and their hateful doctrines of *caste;* supplying a void in the popular faith, manifesting his integrity by his self-denial, and propounding a philosophy plausible enough for the vulgar, and subtle enough to exercise the deepest minds. Miracles were, of course, not wanting, in the belief of his disciples, to the attestation of his powers; but after several wonderful and supernatural escapes from danger, he finished his career, at the age of eighty, by a most unromantic attack of diarrhœa, brought on by eating pork.

To despise forms, to avoid evil, to think kindly of enemies by dwelling on their good qualities, and to put aside revenge by reflecting that its object is only a lot of bones, a skin covered with hair, and a mass of blood-vessels, and to meditate on the perfection attainable by subduing desires, seem to have been the chief teachings of Buddhism, as apprehended by the mass of its early followers; but for the more speculative due provision was made. Gotama Buddha affirmed that a sentient being depended upon, or was composed of, five essentials, called Khandas: "1. Rupa, the organized body; 2. Wedana, sensation; 3. Sannya, perception; 4. Sankhara, discrimination; 5. Winyána, consciousness." Mr. Spence Hardy remarks, "This system tells man that he is a heap, a collection, an accumulation, an aggregation, a congeries, an increment, and nothing more. To develope light, there is the lamp, the wick, the oil, and the flame; and to develope the man, there must be an organized body, and the five Khandas. When the flame is extinguished, the light ceases to be; when the Khandas are broken up, the man ceases to be;" but this negative result is not accepted by all the followers of Sákya-Muni, and is repudiated by the Llamas in Thibet.

Through the operation of Upádána, or cleaving to existence, a new being is produced at the dissolution of the old one, and to this, the Karmma, or aggregate of all the actions and responsibilities of the original being, is transferred. Mr. Hardy gives the following very curious passage on the Buddhist doctrine of continued existence: "On account of awijja, ignorance, sankháro, merit and demerit, are accumulated; on account of these accumulations, winyyánán, the conscious faculty is produced; in consequence of the faculty of consciousness, námarúpa, the sensitive powers, the perceptive powers, the reasoning powers, and the body, are produced; on account of the námarúpa, the body and sensitive faculties, the sadáya-

tanán, the six organs of sense (the eye, the ear, the tongue, the nose, the body, and the mind) are produced; on account of the six bodily organs, phassa, contact (the action of the organs), is produced; on account of contact, wédaná, sensation, is produced; on account of sensation, tanhá, desire, is produced; in consequence of desire, upádána, attachment, is produced; in consequence of attachment, bhawa, existence, is produced; in consequence of a state of existence, játi, birth, is produced; in consequence of birth, decay, death, sorrow, weeping, grief, discontent, and vexation are produced. Even this is the origin of the complete catenation of sorrow."

The Buddhists recognize three phases of being—1. Kama, in the worlds belonging to which (places of punishment included) pleasures and pains result from the exercise of the senses; 2. Rupa, worlds in which are organization and intellect, but no senses; 3. Arupa, worlds in which there are no bodily forms, but sensation, perception, discrimination, and consciousness. There are four of these worlds, the last being a sort of dreamland, in which consciousness is imperfect, there being neither consciousness nor unconsciousness. "Were a sentient being to pass through all these states of existence, in all these worlds, the period would extend to 231,628 maha kalpas, and 12,285,000,000 years."

The nirwána is the state of freedom, from wána, attachment, or desire. "The great rishis (prophets) who are free from wána, desire, call that nirwána which is achutan, that from which there is no going (no transmigration); achchantán, that which has no boundary (neither birth nor death); asankhatán, that which is not affected by cause or effect; anuttara, that to which there is not anything superior; and padán, that to which there is nothing to excel it in advantage."

In Ceylon the nirwána seems to be synonymous with annihilation, and Buddhism is described as atheistic, from its not recognizing any one paramount and supreme self-existing being. It must be a weary soul that can long for the eternal cessation of all sensation and activity, as its hoped for rest; and a religion which inculcates the destruction, instead of the regulation and right direction, of desire, must oppose a tremendous obstacle to social progress; but Buddhism has more theistic aspects in Cochin China, Siam, and Thibet, at least among the more cultivated classes; and as they become gradually acquainted with European science, their implicit credence in numberless absurdities must pass away.

From Mr. Spence Hardy's book, which was originally published in Ceylon, we find he is engaged in a most important controversy with the Buddhists. He assails their religion with all the weapons of rationalistic criticism, and the native priests,

assisted pecuniarily by the King of Siam and a local chief, use the printing press in their defence. Thus we have a very remarkable collision of the western and eastern minds, from which beneficial effects of the highest moment may happily arise.

The Buddhist views of the universe indicate their origin in a pre-scientific period, when mystical imaginations took the place of accurate observation. Boundless systems of worlds, Sakwalas, scattered through space in groups of twos and threes, can all be seen by Buddha, who can tell what is transacting in any one if he wills to know it. "In the centre of each system is a mountain called Sinéru, or Maha Meru. It is 1,680,000 miles from its base to its summit, half of which mass is below and half above the surface of the ocean. On each side it is of a different colour, being like silver towards the east, and like a sapphire towards the south. . . . . It is supported on the three-peaked Trikuta rock, like a vessel upon a tripod." It is also said to be firmly clasped by them as by a pair of pincers. The three rocks rest upon a world of stone. On the summit of Maha Meru is the heaven of Sekra; in the body of the earth are eight places of suffering. Between Meru and the Sakwala ridge are seven circles of rocks, with seven seas between them, and the waters of the seas do not evaporate, and no rain falls in them. The first world is 2,400,000 miles thick. At its base is a stone world, impervious to water, 1,200,000 miles thick, and above it is the world of the earth, which has the same thickness, and below it is the world of water, 4,800,000 miles thick, and below that the world of wind, 9,600,000.

Each Sakwala has a sun and moon. The sun is 500 miles in height, length, and breadth, and its circumference is 1,500,000 miles. The moon is 490 miles in height, length, and breadth, and its circumference 1470 miles, etc., etc.

Buddhist astronomy, physical geography, and natural history proceed in this absurd style, offering an easy victory to real science wherever members of the Buddhist faith can be induced to study it, and to apply its teachings fairly and honestly to the correction of this preposterous legend.

Eclipses are occasioned by a monster nearly 50,000 miles high, who sometimes hides the sun and moon in his mouth, and sometimes covers them with his hand.

It is supposed that Buddha has passed, and will pass through endless forms of existence, for the benevolent purpose of teaching sentient beings the way to permanent peace —the nirwana which we have described; but, as might be expected, the recorded sayings of Buddha are not consistent with the pretensions of such enormous and varied experiences.

The Buddhist method of arriving at truth is one which necessarily passes out of public favour, as scientific and industrial civilization ensue. Solitary meditation in lonely places, carried to a certain point, is expected to bring comfort to the devotee; but he still retains reasoning and investigation, which a continuance of the ascetic process takes away and replaces by a condition of pleasurable intuition. A third process of solitary meditation, if successful, removes joy, gladness, and sorrow, and diffuses through the whole system a perfect tranquillity; and after a fourth process of the same kind, all reasoning, and all attachment to sensuous objects being removed, purity and enlightenment of mind engross the Buddhist saint, like a garment that covers him from head to foot. That those who can sustain the physical discomforts of this route to "perfection," arrive at the most complete and egotistic self-satisfaction, is evidenced not only by Buddhist devotees, but by the ascetic mystics of all ages and of all creeds; but whatever may be the precise dogmas of the superstition that sanctions such practices, they usually lead to the same result, the degradation of the individual, and his withdrawal from the performance of all the duties and obligations imposed upon man as a social being. The ideal of perfection held up before a community that accepts any of the varieties of such a faith is of the most mischievous kind. It renounces duty as well as enjoyment, and looks to annihilation or inactivity as its ultimate reward!

Mr. Spence Hardy attacks the Buddhists by scientific criticism. He tells them that the personal existence of Gotama himself is open to doubt; that all the notions ascribed to him concerning the physical condition of the universe are provably incorrect; that the books in which the legends and opinions of Buddhism are set forth cannot be historical, because they state things which are impossible, and were not written till long after the events they pretend to describe. So far as they are able, the Buddhists reply, and thus the controversy goes on.

Railways, irrigation works, better pay for labour, and the opening prospects of personal advancement to those who are intelligent and industrious—these are the circumstances which seem likely to raise the Oriental mind when they can be brought to bear upon it. The superstitions of Buddhism and Brahminism belong to particular conditions of society, and experience seems to show that extensive changes in speculative thought can only be effected when other changes have prepared the way. The difference between the Oriental and European point of view is enormous, and hitherto no European race has succeeded well in governing and improving Orientals, though

occasionally some gifted individual, like the late Sir C. Napier, in Scinde, has been of wonderful use. Perhaps the industrial development of India may lead the natives to do their part towards reforming themselves. No amount of European benevolence can be a substitute for self-action, and the conservatism of Eastern nations can only be overthrown by movements that develop new interests and create new wants.

KAFFIR PROMISE AND CAPABILITY.

BY DR. MANN, F.R.A.S., F.R.G.S., F.E.S.L., SUPERINTENDENT OF EDUCATION IN NATAL.

(With a Tinted Plate.)

In a recent number of the Intellectual Observer an allusion was made to the curious fact that there is a kind of education going on even among the wild Kaffirs, in consequence of the lives of gossip and of incessant talk that the men lead; and that this becomes at once apparent when the features of the young men are compared with the features of the old men, the countenances of the young men being commonly wild, furtive, and unintelligent, and the countenances of the old men being as commonly gentle, astute, and sagacious. This fact is illustrated in the plate of *Types of Zulu Kaffirs* that accompanies the present number. Figure 3 is the portrait of a young man of Ngoza's people, taken by photography at the chief's kraal, near the base of Table mountain, within sixteen miles of the city of Maritzburg; and Figure 4 is the portrait of Umshiyane, an old man of the same clan, taken by photography at Maritzburg. Figure 3 may be deemed a fair type of the young wild Kaffir of Natal, and Umshiyane is a fair specimen of what the young wild Kaffirs of Natal become after they have gossipped together for half a century.

Figures 1 and 2 of this same plate illustrate another scarcely less interesting fact in connection with Kaffir features, namely, that there are two very opposite types occasionally developed with great distinctness even in the same families—the one having the flat nose, projecting jaw, thick lips, and low cerebral development of the pure negro race; and the other having the small jaw, sharp features, prominent nose, and full capacious foreheads, that must be referred to some higher form of organization. It is not possible to have any extended acquaintance with the Kaffirs of Natal, without feeling that they have much in them that is common to themselves and to the negro. But it is equally apparent that they have

also much that the true negroes want, and that at times comes out in sufficient force to entirely mask the negro organization and blood. There can scarcely be a doubt that the Kaffirs of Natal and its neighbourhood are a composite people, formed by the engrafting of some nobler organization upon the negro stock, and that there is continually a developing out of the leading characteristics of both the lower and the higher element in different individuals. Figure 1 may be taken as a pictorial representation of the lower type, although without the full development of jaw that is often encountered. It is the portrait of a man of the Amabaca tribe, a people who originally dwelt between the site on which Maritzburg now stands and the Umgeni river, and who were driven from that position, at the time of the Zulu invasion, to the river Umzimkulu, at the south-western frontier of the colony, where they now dwell, partly within and partly beyond the British territory. Figure 2 illustrates the higher type of Kaffir organization. It is the portrait of Umkalipa, a subordinate chieftain, who is often seen at the seat of the Colonial Government, and who not infrequently proves a useful man to the authorities. Both these portraits are from photographs taken in Maritzburg by the author of this paper, and both have been very admirably and exactly copied by the engraver.

It is matter of familiar observation that the leading characteristics of the negro organization are very much more softened on the eastern side of the great African continent than they are on its western side. This seems to indicate that the modifying influence is in some way connected with geographical position—that it lies in the east, or more exactly in the north-east. Professor Huxley believes that the Kaffirs are a composite race, mingling distinct elements in their blood, and is of opinion that there has been a migration from the north-east. It looks very much indeed as if some people of higher organization than the true negro, but not disinclined to amalgamate with them, had come from the north, possibly somewhere among the highlands of Abyssinia, and passing through the equinoctial region of this side of the continent, the natural seat of the negro, had mingled with them there, and sent a mixed offset towards the south, where the Kaffir tribes are now found. It is not unworthy of note that Mr. W. C. Palgrave, the great modern authority on Arabian matters, found a people in the province of Oman who present many points of resemblance to the Kaffirs of the highest type. Mr. Palgrave considers that the inhabitants of the central and northern provinces of Arabia are Ismaelitic, and of true Asiatic origin; but that the inhabitants of the southern province and Oman are of different extraction, and come primarily from the high-

lands of Abyssinia. The southern and eastern Arabs, or Kahtanic variety, manifest a remarkable sympathy towards Africans, and readily admit the negro races to social fellowship, not unfrequently intermarrying with them. The emancipated negro in Oman commonly gives his sons and daughters to the middle or lower class of Arab families, and the mixed race springing from these unions are called the "Benoo-khodeyr," or "Sons of the Green one." Mr. Palgrave states that it has been his fate to be honoured by the intimacy of more than one handsome "Green-man," with a silver-hilted sword at his side, and a rich dress upon his dusky skin, but denominated sheykh, or emir, and who was humbly sued to by Arabs of the purest Ismaelitic or Kahtanic pedigree. In reading his description one is almost induced to think that Othello must have been a "Benoo-khodeyr." The Arab town of Riad is full of "Green-men" shopkeepers, merchants, and officers of government. The Ismaelitic Arabs are reserved, self-contained, and of gloomy temper, and narrow and concentrated intellect and will. The Kahtanic Arabs are frank, impulsive, light-hearted, and of social instincts and habits, like the Kaffirs. It must also be added, that so far as the brown, olive, or yellow hue of the skin is concerned, there are unquestionably "Green-men" among the Kaffirs.

In considering the capabilities and possible future of the Kaffir races of Natal, there very naturally arises, first and foremost, the question of hard work. What are they worth, or likely to become worth, as beasts of burthen, and as "sons of toil." They do not take to bodily labour naturally; there can be no doubt about that. But when impelled by circumstances to waive their personal inclinations and predilections in this particular, they can do hard work, and do it well. In the agricultural districts of the colony, Kaffirs are now hired, as field labourers, in considerable numbers. They go to work under monthly engagements, and receive from six to ten shillings per month, and rations, for their service; their food being principally Indian corn, which costs about ten shillings per month for each man. They need to be looked after carefully, and also require, in most instances, to be shown exactly what they are to do. They work very well in gangs, headed by white men. Most of the public works in the colony are carried out by Kaffirs in this way. The roads are made by them. Considerable numbers of them have been employed in the harbour works at Durban for some time; and perhaps in this particular labour their powers of endurance and performance have been more fairly and fully tested than in any other instance. Mr. Arnold Taylor, the agent of the contractor for the construction of these works, had between three hundred

and five hundred Kaffirs in his employment during a term of four years. The men were the rudest and wildest specimens of the race, and were sent to him under the orders of the magistrate for six months' term of service. Most of them, when they arrived, were entirely without a conception of a shovel, a pickaxe, or a lever. Mr. Taylor found that, for rough labour, one of these Kaffirs was equal to two of the very best Indian coolies; and he estimated that one Kaffir was worth about a fourth part of a good English labourer, who would receive four shillings a day in England for his work. These Kaffir labourers required one English leader to look after a gang comprising from twenty to thirty individuals. They took kindly to earth-work with shovel, pick, and barrow. Some made excellent sawyers, in pits with white men at the top, and some became very handy as assistants to English smiths. They were always free to leave after six months' service, and were then replaced by new recruits. One remark made by Mr. Taylor is well worth record and attention. He invariably found that the men who came to him wild, raw barbarians, went away at the end of their service altered beings. Their countenances had become perceptibly brighter and more intelligent. Regular discipline and steady industry seemed to exert the most beneficial influence over their characters. There can be no doubt that well-ordered and well-arranged work, carrying with it the proper remuneration, and bringing in its train new cravings to be satisfied by new efforts of industry, would prove among these people the most certain and most potent civilizer that could be employed in their behalf.

Work on the sugar plantations is, in the main, popular among the Kaffirs for two reasons. The climate is warm and genial on the coast, where the sugar is grown, and treacle is a thoroughly appreciated addition to the daily fare. The chief drawback to the employment of Kaffirs in industrial enterprise up to the present time has been the uncertainty of their labour. It has been found hitherto impossible to induce them to take any long term of engagement. They will work while the humour is on them, but they will reserve to themselves the right to start off to their kraals whenever the humour changes. They are as fitful and capricious as children, and look with ready jealousy and suspicion upon all attempts to impose obligations and constraints upon them. On this account a considerable number of Indian coolies have been introduced into the colony to work upon the plantations, with fixed terms of service. The mail which has just reached England from the Cape brings the most welcome intelligence, that one of the enterprising coast planters in Natal has recently succeeded in inducing the Kaffirs to undertake to clear ground intended for

the cultivation of coffee upon contract by piece-work, the contract for clearance being at the rate of thirty shillings per acre. This is unquestionably a step onwards towards civilization.

With the sole exception that refugee natives who come into the colony from beyond the border are registered and apprenticed out to white masters for three years' service, and that men are supplied to the Government works under requisition from the magistrates, no pressure of any kind is put upon the Kaffir population to induce them to work for European settlers. The affair is entirely one of free inclination under the temptation of wages. Kaffirs living in native villages, either in their own reserved locations, or upon the property of the Crown, or of private holders, come of their own accord to the employers of labour, and make their own terms for remuneration and period of service. The average number of Kaffirs engaged in the service of white men in the colony last year was nearly seven thousand. The terms of service are generally short. This number, therefore, did not by any means represent the sum-total of native men that came under the civilizing influence of labour and personal communication with white masters during the year. The exact number of the black people from whom these supplies of service are drawn is not certainly known. The estimate is made from the number of huts that pay taxes to the Government, and it is assumed that each hut accommodates a certain number of inhabitants. The return made to the Government upon this estimate in recent consecutive years varies between 136,000 and 175,000. It is probable that the latter number is not very far from being correct as the tally of the native subjects of Queen Victoria, residing at the present time under British protection and rule in the colony of Natal. Assuming that one in eight of the Kaffir population is of man's estate within the years suitable for service, the number actually engaged in work is not a very contemptible proportion under all the circumstances of the case. It has yet to be seen that there are many more than those actually engaged in service to white masters, who are steadily within the pale of civilizing influences. It will be inferred from what has been said in a preceding article on the subject of polygamy that, as a rule, Kaffir women do not engage in service to white mistresses or masters. Their service is jealously and exclusively reserved for their own black lords.

Kaffir children manifest a very remarkable facility for the acquisition of book-learning. Children of tender age learn to read with great readiness, and soon become expert with all the simple rules of arithmetic. They are quick with mental arithmetic when well taught. The boys make excellent compositors

WILD KAFFIRS.

and printers. There is a little monthly Kaffir periodical called the *Ikweze*, issued at the American Missionary station, at Esidumbine, which is principally printed by a Kaffir boy. A native lad, named Magema, is the Bishop of Natal's principal printer, and during the bishop's recent absence in England, used to correct the proofs of his work as well as to print them. This lad is very clever indeed, in his vocation, and it is no inapt illustration of the change which the light of civilization can work in these people, that the birth-name of the skilful Magema was "skellum," which, in the Dutch patois, means "rascal."

The missionaries of various denominations in Natal have all been for some time engaged in creating a "literary Kaffir Language," which is printed in books, and in some measure taught in schools by the aid of dictionary and grammar. The chief argument which the missionaries employ in advocating this proceeding is their urgent desire that every Kaffir shall be able to read the Bible. This argument would have considerable weight in it, if it were the fact that the general Kaffir population of the land can read the Bible when it is printed in the Kaffir language. This, however, is not the case. When the Bible is printed in Kaffir, the Kaffirs still cannot read, unless the further labour has been performed of specially teaching them to do so. But in practice it is found that it is really quite as easy to teach Kaffirs to read English, as it is to teach them to read a new written language manufactured out of their own rude tongue. There therefore remains the very important consideration, whether when they are taught to read, it would not be better at once to teach them to read in the English language, which would immediately bring them so much more within the pale of white influences. There are many who think that if one-fourth part the labour which has been given to create a new definite and formal language out of the Kaffir elements, and which the wild Kaffirs do not all understand when it is so created, until they are painfully and gradually taught to do so, had been devoted to teaching them to speak, read, and write English, a tenfold larger result in the way of education would have been gained than is now being realized. Kaffir children who are well taught learn to read and understand the English language much more quickly than to speak it. The faculty of speaking it comes slowly, and with a little difficulty at first; but when mastered, it is spoken well. No doubt the English language seems to them at first a very barbarous one to have to articulate, being so free as it is from clicks and from guttural explosives. The author once asked a young, clever Kaffir girl, who had acquired a fair understanding of English in a school, but manifested a

pertinacious determination not to speak it, for an explanation of her reason. The young lady informed him that she did not like to speak it because she was sure it would make her tongue crooked! The difficulty was entirely removed by the author pledging himself that if such a result ensued, he would set the crooked organ straight by a surgical operation, and by his showing the instruments with which he proposed to effect the rectification. It is, of course, very important that missionaries and teachers should themselves so far understand the Kaffir language as to be able to speak it with facility. The facility is needed, indeed, to enable them to teach English to Kaffirs. Their object should, however, be colloquial rather than literary. It is one thing to speak a rude language familiarly, according to the custom of, and in the idiom of, the people, and another thing to convert that rude language into a written and printed one, to be perpetuated in a fixed and definite form for special teaching.

The Kaffir men manifest a very great eagerness to learn to read and write. They look upon the art as a sort of magic which the white man employs in carrying on the wonderful operations of his strange life, and they think it a very desirable thing to qualify themselves for similar performance. This is strikingly, although somewhat ludicrously, illustrated by the way in which young Kaffir men may be seen striving to effect their purpose in the principal large towns of the colony. Evening after evening gatherings may be seen of young Kaffirs who have been at work all day, and who then assemble round some wall tablet, and repeat simultaneously, with stentorian energy, B-a, ba; B-e, be; B-i, Bi, as one of their number points to the printed characters with a wand. It is almost painful to note the patient and resolute way in which these young fellows pursue the exercise hour after hour and night after night, in the faith that they are rapidly becoming adepts in wielding the white man's instruments. If the public income were sufficient for the work, the Government would experience scarcely any difficulty in establishing native schools for English instruction, even among the wildest and most retired natives. It once occurred to the writer to receive a visit, in a wild part of the country, from a powerful young barbarian chief, who came with a company of his old councillors to offer to build a school hut at his kraal, if the Government would send him a teacher to instruct the children of his people there. He explained that the principal ground of his request was his desire to be able, in case of need, to communicate with the head of the state by means of a messenger carrying his words in a written document. In consequence of the extreme youth of the colonial community, and the great demand that there is

for the employment of the public revenue in works of general utility, the Government is not yet able to devote any large sum to the furtherance of the work of native education. The expedient course has therefore been taken of giving small grants in aid from the public funds to the various missionary establishments already having a footing in the land, upon the condition that the English language and industrial pursuits are taught to the native children of the neighbourhood. It would unquestionably have been better for the immediate prospect of success if the Government could have taken the work of secular native instruction entirely into its own hands, because among the wild native people the influence of prestige is in favour of the Government and against the missionaries. The wild natives are generally suspicious of the missionaries, because they are so very zealous in their work, and because they preach energetically against polygamy. The natives think it is quite impossible for men to be so personally eager about making converts, unless for their own purposes and for their own gain. The alternative plan, which has been adopted on economical grounds, of using the agency already established on the field by missionary spirit and enterprise will, in the meantime, produce very decided results in the right direction, until more energetic and costly measures can be added. The system alluded to has only been in force three years, and there are, at the present time, as a first instalment, 1700 Kaffir children learning English at the various schools, of which one is a central training school, where the most promising native pupils from other schools are received to complete their education as pupil teachers. The cost to the Government of the common native schools is a trifle in excess of £900 per annum, and, in the last year, contributions were made in ten of these schools by the Kaffirs themselves in aid of their support, amounting in the whole to £205 12*s.* 9*d.* The Colonial Government also furnishes £1000 a year to these schools, for industrial training of natives. The amount is expended in the payment of salaries to skilled labour masters or mistresses. Last year about 120 boys and girls were benefiting by these industrial grants, of whom several were under regular indenture for fixed terms. The lads in these industrial schools are trained as carpenters, cabinetmakers, waggonmakers, brickmakers, stonemasons, builders, thatchers, tailors, and shoemakers. They readily attain fair proficiency in all these arts. Most of the extension of the buildings on the principal stations is now performed entirely by the boys; and, in some of the most advanced schools, the boys are beginning to go out as hired workmen to settlers living in the neighbourhood.

There is no more interesting subject of observation and

thought than the proceedings of Christian missionaries in wild lands. In the small and young colony of Natal, there are thirty-six stations occupied by resident missionaries, of which nearly one-third belong to the American Board of Missions. There are several Norwegian missionaries residing in Zulu Land, far beyond the British territory. As a rule, these missionaries settle down in remote wild districts, and build themselves houses there, where other objects and influences do not yet bring civilized men to dwell. Some few of the wild natives gather round their dwellings, fix their huts upon the missionary grounds, attend the missionary religious services, and send their children to the missionary schools. There are altogether about 3000 native people attending the services of the thirty-six missionary stations in Natal. Some of these go for curiosity and amusement; some for what they can get; and some are serious converts to the Christian practice and creed. Whatever may be thought of the actual economy of missionary work, on comparing results with outlay; or of the question whether from Christianity to civilization, or from civilization to Christianity, is the natural and appointed progress for barbarous man, there can be no doubt of the fact that these missionary stations, scattered through the wilderness, do serve as most valuable outposts in the attack of civilization upon barbarism. The most careless and casual comparison of a wild native kraal, with a missionary native village in Natal, serves to establish at once this fact. In the wild kraal the Kaffir is a naked savage, squatting in the sunshine, or skulking in his straw bee-hive, amidst equally naked women, whenever *they* find intervals from the bodily drudgery of drawing his water, bearing his burthens, or delving his ground. In the missionary village the Kaffir is a clothed man, living in a square house with a wife and a family of children, who derive their daily bread from the sweat of his brow, and beginning to understand the dignity of labour, the responsibilities of rational existence, and the value of temporal possessions. In many instances he is a curious creature in his new-fledged state, and bears his unaccustomed graces with a very manifest expression of self-complacency. Deference to the white man is a striking and constant feature in the character of the wild Kaffir. He is even slow to follow the example which civilized life sets before him in social things, because he looks upon the white man as a being of an altogether higher order than himself, and as the proper inheritor of special gifts and arrangements in which he can have no part. One of the answers occasionally made to missionary appeal by wild Kaffirs is, "Oh, yes; that is all very true. There is no doubt a great Spirit who looks after,

and cares for the white man. But He has nothing to do with the black men. The black man has no protector of that kind." When the missionary has just succeeded in getting so far with him as to lodge skin deep the idea that he has been mistaken in this, and that the Great Spirit of the white man does care for him, and that he is a "man and brother," it can hardly be matter of surprise if he begins to think rather better of himself than he did before, and if his natural deference and modesty gives place to self-assurance and personal conceit. There is no doubt that the phase is but a transitional one, and that a prolonged experience of the conditions and working of civilized and Christian life will assuredly bring its own remedy for the evil. Still the tendency is well worthy of note, because it points to one obvious precaution which missionaries may easily make a part of their programme when they prepare themselves to deal with the raw material of barbarism.

It is also deserving of remark that the missionary stations in Natal, which are so placed as to afford an industrial career for the natives resident at them, are those which are manifesting the surest signs of vitality and success. Wherever townships, or fairly prosperous settlements of white people have grown up in the close neighbourhood, so that there is transport work to be performed by waggons and oxen, and a ready market for such articles as the Kaffir can make, or such produce as the Kaffir can rear, or where there is a sugar-mill at hand to manufacture such cane as he may be able to grow, there the native Christian communities thrive and enlarge quickly. Upon the whole the most successful missionary station in Natal is that of the Umvoti. This station was established by Mr. Aldin Grout, one of the fathers of the American Mission, in the year 1844. A few years since the Colonial Government erected steam machinery for the manufacture of sugar at this station, with a view to encourage the growth of the cane among the natives. One half the sugar manufactured is taken by the Government to cover the cost of manufacture, and the other half belongs to the native planters. At this station there are now sixty-seven square European houses inhabited by native sugar-planters, who for the most part employ their own native waggon-drivers as hired servants. Many of these men are estimated to have property belonging to them at the present time of the value of not less than £800 a-piece. Mr. Grant believes that two of them are worth £2000 each. These planters have built a large brick church, capable of accommodating a congregation of 500 individuals, at their own cost, and they contribute £75 yearly for the maintenance of a school for the education of their children.

The most remarkable instance of the industrial capability of the Kaffir that has come within the writer's own personal experience yet remains, however, to be given. At the missionary station of the Amanzimtote, on the southern coast, and sixty miles away from the Umvoti station, there lives a Kaffir named Nembulo. This man, having heard of the wonders which the sugar-mill at the Umvoti was working, one day took his staff, and walked off to look into the matter with his own eyes. He returned home from the Umvoti, pondering upon what he had seen. When he had completed his deliberations, he went to a native intimate, named Uncaijana, living close by, and proposed to him that they two should buy a sugar-mill for themselves, and grow and manufacture sugar at the Amanzimtote! His overtures being well received by his companion, he next visited a white planter, Mr. Sidney Platt, residing near Durban, and bargained with him for the purchase of a small steam-mill, that Mr. Platt was wishing to replace by a larger one, the exact terms of the bargain being that Nembulo was to begin to pay for the mill one year after he had commenced operations, that all the sugar made was to be devoted to the payment until the debt was cleared, and that the price was to be £500. In the year 1864, the writer chancing to hear of this spirited proceeding when he was in the neighbourhood, sent for Nembulo, and questioned him about his plans. The only doubt about them seemed to be whether the Kaffir would be able really to get his mill fairly started, to make the money which was to pay the debt. After due consideration of all the features of the case, the writer brought the affair under the notice of the Lieutenant-governor, and procured a loan of £100 from the Government, to be expended in removing the mill to Nembulo's place, and in setting it to work there. In the month of June, 1865, the writer again visited Nembulo, to see how he had succeeded in his enterprise. He found the Kaffir stripped to the waist, driving the steam-machinery of a pretty little mill, the rollers of which were being fed with cane by the women of his family. There was no white man near him. He was "monarch of all he surveyed," and master of the position. When questioned, he gave the writer a very lucid explanation of the safety-valve, and some other parts of the machinery. He had just manufactured five tons of very excellent sugar. His Kaffir neighbours had already planted a considerable stretch of cane, and he stated that he expected to be able to pay off his entire debt, which then, including the advance from the Government, amounted to £700, within two or three years. He found that he was able to manufacture twelve hundredweight of sugar (worth from £12 to £15) per day. His first year's crop was estimated at about seven tons. The history of

his proceedings since the previous year was, that he had procured an engineer from Durham to remove and erect the mill for him. He had then retained the man three days to give him a lesson in managing the machinery, and at the end of the three days dismissed him with a payment of £95 for his services, and immediately afterwards carried the £5 which remained of the Government loan to Mr. Platt, as the first instalment of the purchase-money. Having settled this piece of business, he filled up his time until the crushing season arrived, by going about from mill to mill to perfect his knowledge of the machinery; and when the proper time did come, he started his own machinery single-handed, without a single mishap, and worked it with entire success.

One other fact is all that can now be added to the arguments and illustrations of this paper. It is a trifle in itself, but it is a trifle that is full of meaning and promise, and therefore well worthy of record. Not very long since the writer was riding on horseback in Natal, quite alone, and in a wild part of the country, when greatly to his surprise he came suddenly upon a large surface of the open ground, unmistakably traced by the familiar furrow of the plough-share. There was a wide horizon round, and no sign of human life in sight, and no other token of the neighbourhood of civilized appliance. He was quite aware that there was no white man's house within many miles. At the end of the day's ride he found the solution of the enigma by learning that the wild Kaffirs of that district were in the habit of sending twenty miles to a settlement of their more advanced brethren which possessed draft oxen and ploughs, to get one of the fraternity to bring up the magic implements and break up the ground for their grain-crops.

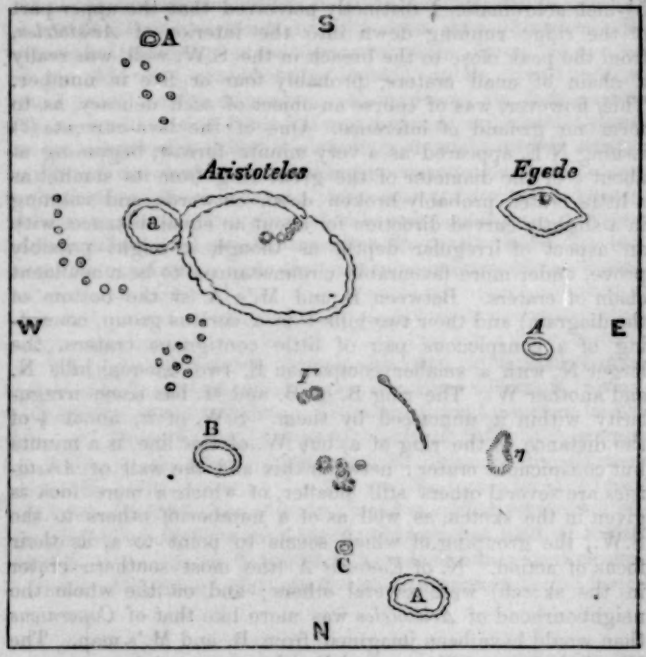
It will be seen from the several statements contained in the preceding pages of this paper that an interesting social problem is in process of practical solution in Natal. Certain important questions, that relate to the future destinies of a large race of mankind are being there put to the test of actual experiment under eminently favourable circumstances. The contingency is the work of what is ordinarily termed accident, rather than of design. A black race, under the immediate influence of a reign of tyranny and terror, is flocking in to the midst of an industrious English community settled in an exceptionally fine and congenial climate. In order merely to put some check to the rapidity of this black exodus from beyond the Tugela, the colonial authorities have found it essential to enact an ordinance providing that all cattle brought into British territory by refugees shall be given back to the Zulu chiefs on formal demand, and that the refugees themselves

shall be registered, and apprenticed to English masters for a term of three years. The English rule is already more popular with the great majority of the wild Zulu people beyond the border than their own government. The smile of Queen Victoria has more power on the banks of the white and black Umfolusi in Zulu land than the frown of the shade of Chaka. Mr. Shepstone, the Secretary for Native Affairs in Natal, is of opinion that the instant the two restrictions alluded to above are relaxed, or withdrawn, the remaining fragments of the Empire of Chaka and barbarous Zuludom will crumble into pieces. Within the last few months, since the writer of these pages has left the land that he is speaking of, the Basuto chief Moshesh, beyond the north-western frontier, has sent a special messenger to the British High Commissioner to say how ardently he desires that his people, another division of the great Kaffir family, should be enrolled among the black children of the British Queen. The race that is concerned in these movements of contemporaneous history combines in itself the docility of the negro, with certain mental qualities that are of a higher order than those of the negro. Therefore, no theory that can be shown to affect the true negro, and no experience that has been reaped from the true negro, can be relied upon in reasoning upon its future destinies. The final issue of the Natal experiment is yet in the obscurity of time. But this much at least is known—so far as the British territory is concerned this interesting aboriginal people must either be converted into an industrious and civilized community, serving the interests and co-operating in the objects of their white and more highly gifted brethren, or their places on colonial ground must become vacant. Civilization and barbarism cannot long stand side by side, or face to face. In such a state of affairs the few notes that have been placed on record in these pages cannot be held to be without deep interest, both as indications and as suggestions—as indications of what may fairly be hoped for, and as suggestions of what may possibly be done.

LUNAR DETAILS.—OCCULTATIONS.

BY THE REV. T. W. WEBB, A.M., F.R.A.S.

INCREASING evidence is constantly adding to the conviction, already sufficiently strong, that in proportion as more powerful telescopes and more careful attention are brought to bear upon our satellite, the inadequacy of existing representations will become more apparent; and that, without a more minutely



accurate delineation of the surface, the majority at least of our conclusions as to continuance of physical change are insecure. Our readers may be interested in becoming acquainted with an instance of this, which came before the writer not long ago. In our number for February last, a diagram was given of the great crater *Aristoteles* and its immediate neighbourhood, pretty accurately copied from the map of Beer and Mädler; and from its character, as well as that of their accompanying description, it would appear that they paid much attention to this curious

region. Yet a view of the vicinity, which I subsequently obtained on April 21, enabled me to add a few features, some of which, at least, it is strange that they should have overlooked. It is now to be regretted that the sketch in the February number did not include a wider area, so as to give room for a more interesting comparison; our purpose, however, will be sufficiently answered by the accompanying diagram, in which the lettered objects only are to be found in the map of B. and M.

With a power of 212, and very good definition in my $5\frac{1}{2}$-inch achromatic, I distinctly perceived that the upper part of the ridge running down into the interior of *Aristoteles*, from the peak close to the breach in the S.W. wall, was really a chain of small craters, probably four or five in number. This, however, was of course an object of such delicacy, as to form no ground of inference. One of the lava-currents (?) issuing N.E. appeared as a very minute furrow, beginning at about $\frac{1}{3}$ of the diameter of the great ring from its summit as a little crater, probably broken down outwards, and running in a slightly curved direction for about an equal distance, with an aspect of irregular depth, as though it might possibly prove, under more favourable circumstances, to be a confluent chain of craters. Between B. and M.'s A (at the bottom of the diagram) and their two hills Γ is a curious group, consisting of a conspicuous pair of little contiguous craters, the larger N, with a smaller companion E, two unequal hills N. and another W. The ring B, of B. and M. has some irregularity within it, unnoticed by them. S.W. of it, about $\frac{1}{4}$ of the distance to the ring of a, but W. of the line, is a minute but conspicuous crater: between this and the wall of *Aristoteles* are several others still smaller, of which a mere idea is given in the sketch, as well as of a number of others to the S.W., the grouping of which seems to point to a, as their focus of action. N. of *Eudoxus* A (the most southern crater in the sketch) were several others; and on the whole the neighbourhood of *Aristoteles* was more like that of *Copernicus* than would have been imagined from B. and M.'s map. The W. of their two hills marked Γ either is a regular crater, or has a cavity on its summit.—April 23, 24, 25, the furrow could still be seen, though with decreasing visibility: the group of three craters between A and Γ remained conspicuous. April 23, I could still see the pit on the summit of the western Γ. All these objects therefore are confirmed, and the group of little craters in particular is shown to be an object of persistent visibility under varied illumination.

This assemblage of three craters and three hills had been previously discovered, together with several other very minute

craters near *Aristoteles* and *Egede*, Jan. 23, and reviewed Feb. 22, by Mr. Leigh, then of Birkenhead, with a very fine 9¼-inch silvered speculum by With, but I had not at that time before me the sketch with which that gentleman had favoured me, nor any other than a very general recollection of its nature. I have no doubt the larger crater might be perceived with much less powerful instruments.

Now, are we to suppose that these objects did, or did not, exist at the time of B. and M.? In the face of their own drawing and description, it cannot be pleaded that this is an out-of-the-way region, which a selenographer might perhaps be pardoned for scrutinizing with less care. Nor can the admitted inferiority, as to light, of their optical means be alleged, when a portion of the objects, at least, are so very readily and persistently seen. A reference to Lohrmann's map shows us one of the twin craters, and so far tells against his contemporaries. But the question, it would appear, admits as yet of no completely satisfactory answer; and the same inquiry might be made, with the same ambiguous result, in examining many other parts of the lunar hemisphere. There must evidently be greater precision in detail before we can form safe conclusions as to the present condition of the moon.

OCCULTATIONS.

Jan. 8th, 18 Aquarii, 6 mag. 4h. 4m. to 5h. 2m.—9th. B.A.C. 7774, 6 mag. 6h. 2m. to 7h. 10m.—16th. θ Tauri, 4½ mag. 4h. 1m. to 4h. 39m. 75 Tauri, 6 mag. 4h. 4m. to 4h. 50m. θ^2 Tauri, 4½ mag. a near approach. B.A.C. 1391, 5 mag. 4h. 47m. to 5h. 48m. ALDEBARAN, 7h. 26m. to 8h. 37m.—17th. 130 Tauri, 6 mag. 11h. 59m. to 13h. 6m.—18th. 26 Geminorum, 5½ mag. 7h. 44m. to 8h. 48m. (The night of 16th will be marked by especial interest, though too near the Full Moon to admit of the visibility of the dark limb; or give any chance of the optical phenomenon of "projection.")

OBSCURATION OF A LUNAR CRATER.

BY W. R. BIRT, F.R.A.S.

ALTHOUGH the disappearance of a crater on the moon's surface may not possess such an amount of interest as the sudden outbreak of a star, or a shower of meteors, as the earth plunges into a congeries of minute bodies, circulating around the sun—the two leading astronomical facts of the year 1866—yet, as giving us, inhabitants of the earth, intelligence that some change is taking place on the surface of our nearest celestial neighbour, every circumstance indicating that a portion of that surface is not in *precisely* the same condition as it was a few months since, must be regarded as extremely interesting; especially when we consider that "change" is the principal means by which we become acquainted, in a more intimate manner, with the physical constitution of bodies.

On the extensive lunar plain known as the *Mare Serenitatis* (INTELLECTUAL OBSERVER, vol. viii., p. 292) stands a crater named "Linné," in W. longitude, 11° 32′ 28″ and N. latitude, 27° 47′ 13″. The crater, which is 5·6 English miles in diameter, is situated upon one of those low ridges, described by Mr. Webb, and is perfectly isolated, according to our maps; neither Lohrmann, nor B. and M. give any other in its locality, nor does Schröter; but it is not a little remarkable, that when observing the *Mare Serenitatis*, on the 5th of November, 1788, he saw in the place of "Linné" a dark diffused, but not sharply bordered spot, of not more than ½° of light. Lohrmann saw the crater very distinctly, and measured its position. B. and M. also saw it distinctly, and made seven measurements for position. The indefatigable astronomer Herr Julius Schmidt, the Director of the Observatory at Athens, who has devoted much of his attention to the study of the lunar surface, for more than a quarter of a century, has known the crater since the year 1841, and never found it difficult until October, 1866, when instead of seeing the well known object, he could perceive nothing but a glimmer, a small whitish cloud in its place, and this was repeated in November, so that for upwards of one month, this somewhat conspicuous object must have been under a cloud.

It is hardly likely that this phenomenon can be any other than a *concealment*, and it would be interesting to know, if such were the case, when Schröter recorded the dark spot in its place. This is very probable, as the crater is distinctly shown *on the ridge* in Ricicoli's map, published 1653. The most recent observations, December, 1866, show that the

extent of the whitish spot in the place of "Linné," is *greater* than the diameter given above. Upon comparing "Linné" with the standard spot, "Dionysius"—the diameter of which as given by Lohrmann, is 13·8 English miles, and also as measured on Rutherford's photograph—the magnitude—that is, the ratio in size, which "Linné" bears to "Dionysius," reckoned as unity—is 0·40; while on Dec. 15, 1866, its magnitude was 0·79, this will give 10·9 English miles for the extent of the whitish spot *over the crater*, which is exceeded by 5·3 miles. Lunar observers will doubtless watch the locality with great interest, especially as at the time when the terminator was near the spot, it was quite invisible. Whatever the cause of the obscuration may be, it is to be hoped that the first indication of the returning visibility of "Linné" may be made public, so that the period of its concealment may be well determined.

Closely allied to the observations of Herr Schmidt, is a series by the writer of this paper. Between the years 1858 and 1863 when the Sun had attained a considerable altitude above the *Mare Crisium*, a white ill-defined cloudy patch was regularly observed a little W. of the well known crater "Picard," but it was not seen about the time of sunrise or sunset at Picard. Nothing appeared to throw any light upon this appearance until the year 1863, when in the neighbourhood of the cloudy patch, a little before sunset, a small pit-like marking was noticed. In the year 1864 the attention of Mr. Ingall was arrested by a spot 6° or 7° of brightness in this locality, and towards the end of the year, the cloud-like patch had nearly faded out. On December 12, 1864, Mr. Knott, at his observatory, Woodcroft, Cuckfield, Sussex, examined the locality with his 7½-inch Alvan Clark, and discovered two minute craters, I C$^{mu\ 2}$ and I C$^{mu\ 3}$ of the new nomenclature. It was some time before this discovery was confirmed, as the smaller crater I C$^{mu\ 3}$ was very difficult to catch; at length, towards the end of 1865, Mr. F. Bird of Birmingham, saw the pair with his silvered glass mirror, the writer having previously seen them at Cuckfield, in October, 1865.

It is extremely difficult to say if these craters were really new, still the facts are sufficiently interesting to induce a very careful scrutiny in the neighbourhood of "Linné," especially as from the observation of Schröter there is reason to believe that the crater has suffered two obscurations within a period of 80 years.

Upon receipt of Herr Schmidt's letter to the writer, a translation of which we give below, the Moon Committee of the British Association issued a circular, calling the attention of astronomers to the interesting fact recorded in it. It is

probable some valuable observations will result from the adoption of this course.

P.S. Since the preceding was in type, we have received a note from Mr. Birt, with the following additional information:—

"Mr. Buckingham of Walworth, has obtained several photographs of the Moon, in October and November, which I have examined. In almost all I find the place of 'Linné,' but the object is very faint. I have one which he took on November 18, 1866, at 6·30 S.M.T. In this 'Linné' is visible, but its light I estimate, by comparison with the ground around Copernicus, to be only 2°. I have collected all the recorded brightnesses and compared the photographs which I have in my possession. The results are as follow:—

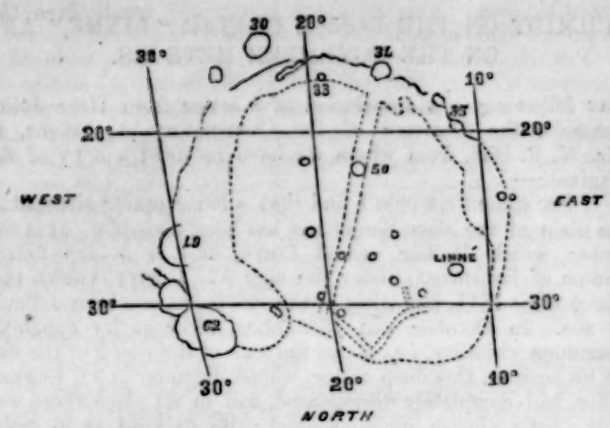
"Variations of brilliancy of the crater 'Linné,' since the year 1788.

Observations.			W.R.B.
1788, Nov. 5.	Schröter	0·5	0·125
1823, May. 28.	Lohrmann	7·0+	
1831, Dec. 12, 13.	B. and M. Photographs.	6·	
1858, Feb. 22.	De la Rue	5· glass.	
1865, Oct. 4.	„ „	5· print.	
	Rutherford	6· „	
1866, Nov. 18.	Buckingham	2· „	

"The above values for the photographs have been estimated, and may be considered as a continuation of the series, W.R.B.; except Rutherford's, which is brighter than any degree of this scale. There is some uncertainty in the determination of the brightness on the prints, but the difference between 6° and 2° is, I apprehend, too great to be attributed to differences arising in the printing.

"The crater appears to have been brightest in 1823; Lohrmann always saw it brighter than Conon, which he records at 7°·0.

"From these records, it appears that Lohrmann and B. and M. observed 'Linné' to be *brighter* than any degree of the scale you have—*i. e.*, brighter than the surface around Kepler. Schröter's observations give about the eighth of a degree of my scale; but De la Rue's photographs give a brightness of about that of the surface around Kepler; and Rutherford's brighter—probably the same as B. and M.'s. Buckingham's series is so far accordant with Schmidt's observations as to indicate, very strongly, that the crater has really undergone a change of some kind."



THE MARE SERENITATIS, FROM MADLER'S SMALL MAP.

References.

No. 30	Plineus.	49	Le Mounier.
„ 33	Taquet.	50	Bessel.
„ 34	Menelaus.	62	Posidonius.
„ 35	Sulpicius Gallus.		

The interior dotted line, shows the boundary of the dark border of the *Mare*. The exterior of the *Mare*, on the N. is not shown, as it is not so well marked as the S.; the white streak, part of a ray from Tycho, across the *Mare*, is indicated by the double dotted line, from Menelaus to the N. border.

RECORDED OBSERVATIONS OF LINNE.

1788, Nov. 5. Schröter.
Dark spot in place of the Crater.
1823, May 28. Lohrmann.
1 Measure. Always saw it brighter than Conon in the Apennines.
1813, Dec. 12, 13. Mädler.
7 Measures. No remarks on its appearance.
1866, Oct., Nov. Schmidt.
Obscured; only a little whitish cloud visible.

SCHMIDT ON THE LUNAR CRATER "LINNÉ," AND ON THE NOVEMBER METEORS.

The following is a translation of a letter from Herr Julius Schmidt, the Director of the Observatory at Athens, to Mr. W. R. Birt, from whom we have received a copy of the original:—

"For some time past I find that a lunar crater situated in the plain of the Mare Serenitatis has been invisible. It is the crater which Mädler named Linné, and is in the fourth section of Lohrmann, under the sign A. I have known this crater since 1841, and even at the full it has not been difficult to see. In October and November, 1866, at its epoch of maximum visibility, *i.e.*, about the time of the rising of the sun on its horizon, this deep crater, whose diameter is 5·6 English miles, had completely disappeared, and in its place there was only a little whitish luminous cloud. Be so kind as to make some observations on this locality.

"At Athens, I observed the great meteor shower on the night of the 13-14th November. On the nights of the 12th and 14th, the sky being partially clear, the hourly number of meteors was very small. On the night of 13-14th the sky was perfectly clear, and we found the meteors very scarce between 6 and 12 o'clock; but later the hourly number became enormous, and the spectacle was very brilliant and magnificent by reason of the great number of bolides. From observations made between 6 and 14 hours, and from 16 to 18 hours, and from an approximate calculation, I found the maximum, on November 13th, 14h. 15m., Athens mean time, and the number per hour for one observer = 1055. Almost all the meteors —that is to say, 343 out of 345—came from a radiant point in the vicinity of γ Leonis."

This letter has been communicated to the Lunar and Luminous Meteor Committees of the British Association.

THE NOVEMBER SHOOTING STARS.

BY THE HON. MRS. WARD.

(*With a Woodcut Illustration.*)

TRUE to astronomical prediction, the great November shower of meteors arrived on the night of November 13th, and continued to stream in radiant succession during the early hours of the 14th. Those observers who for years have devoted close attention to luminous meteors, hailed this opportunity for ascertaining fresh facts with regard to their distance, velocity, and physical properties, and for becoming acquainted even with their chemical nature, by the wondrous process of spectrum analysis.*

Some of the results of such observations will probably be laid before the readers of this periodical. My remarks in this paper are intended merely to afford answers to such questions as are likely to be asked by intelligent observers, to whom the whole subject of meteors is new, but who have felt interested by the beautiful display on the morning of the 14th of November; and, secondly, I wish to describe the scene for the benefit of those who, with considerable vexation, are constrained to own that they forgot to look out, and have missed the sight altogether.

For my own part, I narrowly escaped a similar fate. I knew the ordinary November meteors only by hearsay, having watched for them vainly, on the nights of the 12th and 13th in two or three former years; and my attention had not been much attracted by the notices given in the INTELLECTUAL OBSERVER, and elsewhere, of the probability that the flight of meteors *this* November was likely to be of imposing appearance.

But now—the morning of the 14th has passed—I have seen the November shooting stars in all their beauty and grandeur, a phenomenon unequalled since 1833, and my thoughts turn to the hundreds of observers who probably saw them also, and who inquire with newly-awakened curiosity, What are they? Whence do they come? What possible reason can be given for their appearance on a fixed day in our calendar? And what grounds were there for supposing that a more splendid display than usual would be seen in 1866?

What are they? And whence do they come?—These are questions difficult to answer; but for the answering of them a vast quantity of evidence has been collected within the last few years, and all observations seem to confirm the theory,

* See INTELLECTUAL OBSERVER, August and October, 1866.

that they do not belong to this earth or its atmosphere, but that on the contrary they are *from afar;* and that they circulate round the sun in definite orbits.

On almost any fine night a few shooting stars will be seen; such is the experience of those who have watched for them in various parts of the world. A bright object, looking like a star, is suddenly seen moving a little way through the heavens, and then disappearing. They are common at all times, and, to use Professor Ansted's words, "they are as little exceptional as clouds." These are the ordinary shooting stars, which I have seen hundreds of times, though generally not more than three or four of them during one evening: but we have now to speak of those which are known to be *periodical* in their displays, and by the pre-concerted observation of which, some knowledge has been gained respecting the shooting stars in general.

On several occasions these wanderers have appeared, not few and far between, but in astonishing numbers, conveying the idea of a shower of rockets, or of snow-flakes falling. Observers have noted the dates of such appearances, and the very remarkable fact has been established, that the greatest displays of the kind have uniformly happened on the night between the 12th and 13th, or on that between the 13th and 14th of November. Time out of mind those identical days, or those directly corresponding to them have been occasionally signalized by such exhibitions.

They appear likewise on the 10th of August, and more or less on the 9th and 11th also. The display is less brilliant than in November, but more *certain*. The November show is often interrupted for a number of years, but on those three days in August shooting stars are almost sure to be seen. Other epochs have also been, to a certain extent, established.

And here our third question must be answered—"What possible *reason* can be given for their appearance on a fixed day in our calendar?" A reason *has* been given; and it is so well stated by Sir John Herschel, that I shall give his remarks *verbatim*.* "It is impossible," he says, "to attribute such a recurrence of identical dates of very remarkable phenomena to accident. Annual periodicity, irrespective of geographical position, refers us at once to the place occupied by the earth in its annual orbit, and leads direct to the conclusion that at that place the earth incurs a liability to *frequent* encounters or concurrences with a stream of meteors in their progress of circulation round the sun. Let us test this idea by pursuing it into some of its

* *Outlines of Astronomy*, Art. 901. (1859.)

consequences. In the first place, then, supposing the earth to plunge, in its yearly circuit, into a *uniform ring* of innumerable small meteor-planets, of such breadths as would be traversed by it in one or two days; since during this small time the motions, whether of the earth or of each individual meteor, may be taken as uniform and rectilinear, and those of all the latter (at the place and time) parallel, or very nearly so, it will follow that the relative motion of the meteors referred to the earth as at rest, will be also uniform, rectilinear, and parallel. Viewed, therefore, from the centre of the earth (or from any point in its circumference, if we neglect the diurnal velocity as very small compared with the annual) they will all appear to diverge from a common point, *fixed in relation to the celestial sphere*, as if emanating from a sideral apex."

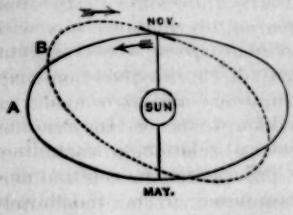
Here Sir John Herschel refers us to his very interesting remarks in an early chapter on the subject of "celestial perspective"—"that branch of the general science of perspective which teaches us to conclude, from a knowledge of the real situation and forms of objects, lines, angles, motions, etc., with respect to the spectator, their apparent aspects as seen by him projected on the imaginary concave of the heavens; and *vice versa*, from the apparent configurations and movements of objects so seen projected, to conclude, so far as they can be thence concluded, their real geometrical relations to each other and to the spectator." He then proves that in celestial perspective "every straight line (supposed to be indefinitely prolonged) is projected into a semicircle of the sphere, *that*, namely, in which a plane passing through the line and the eye, cuts its surface. And every system of parallel straight lines, in whatever direction, is projected into a system of semicircles of the sphere, meeting in two common apexes, or vanishing points, diametrically opposite to each other." This digression is to explain what is meant by a "sidereal apex." And here let me anticipate. On the morning of Nov. 14th, when I saw the meteors emanating from a point at some distance above the horizon, when I observed many of them mounting overhead, and the whole display retaining the form of a canopy, while tending as if to some point far below the opposite horizon, I felt that *perspective* had in some way a great deal to do with their aspect, and that I should not think of them as of sky rockets shot in real curves *over the house;* but it required the luminous words of Sir John Herschel to place the matter in an intelligible form. Let us now take up the thread of his argument.

The shooting stars, he says, ought to appear to diverge from a common point; and he proceeds to tell us, "This is precisely what actually happens. The meteors of the 12—14th

of November, or at least the vast majority of them, describe apparently, arcs of great circles, passing through or near γ Leonis. No matter what the situation of that star with respect to the horizon, or to its east or west points may be at the time of observation, the paths of the meteors all appear to diverge from that star."

The exact position in the heavens from which the meteors appear to radiate, technically known as the "radiant point," is one of the subjects to which the attention of observers has been of late years much directed, and the spot which it occupies in Leo has probably been ascertained with great precision on the present occasion.

And now to sum up the theory, so far. We suppose the earth in its orbit, A, around the sun, to encounter a ring of meteors, B, at the point marked "Nov." There, and there only, we are led to believe, the orbit intersects the ring. At the opposite point, marked "May," the ring falls a little within the orbit of the earth, instead of cutting through it. A display of the meteors in this ring can therefore occur only in November. Now if the ring were *uniform*, *i. e.*, an unbroken stream of meteors through its whole circle or ellipse,* the earth's encounter with it would take place every revolution—we should see an exactly similar star-shower every November 13 or 14.



But "if the ring be broken,"—here again I quote Sir John Herschel—"if it be a succession of groups revolving in a period not identical with that of the earth, years may pass without a rencontre; and when such happen, they may differ to any extent in their intensity of character, according as richer or poorer groups have been encountered." A *blank* part of the ring will occasionally occupy the point of intersection just as the earth arrives there—then there will be no November meteors visible that year. Again, a *rich* part of the stream, the *jewel* of the ring, of which we shall presently have much to say, may come to the point of intersection when the earth is there—then we shall have a glorious display, as in the year 1866.

Or, let us suppose we meet a thinner part of the ring, then we have an ordinary November star-shower, such as those which occurred in 1822, 1823, 1832, 1833, etc.; or, to take

* It is believed to be nearly circular.

more recent years, a display of them seen from Malta on Nov. 13th, 1864, when clouds obscured the sky in England, and in 1865, when a considerable number (250 per hour) were observed from Greenwich.

A ring of meteors in space, large almost as this earth's great track round the sun—what a wonderful idea, when one comes to consider it, or to represent it in a diagram! *One* ring! there are probably *several*, belonging to the various periodic groups of these strange bodies which up to the present time have been detected. The August meteors are as well-marked a group as those of November; they, too, have a sidereal apex always the same at each return, but it is far away from Leo, being close to the small star B Camelopardali. Certain other star-showers, also proved to be periodical, have also their points of radiation; and though in some cases these are not actually to be described as *points* but rather as *regions* of radiation (implying perhaps a want of parallelism in the movements of the meteors), astronomers still hold that it is highly probable that all shooting stars are grouped according to some law, and may form a number of rings, some nearly circular, some of a lengthened elliptical form, like those of comets; and that those which appear to be not periodical may be out-liers of such rings.*

Nor are the positions or dates of appearance the only distinctive features of the various groups of shooting stars, they have their own individuality—"The meteors of particular showers vary in their distinctive characters, some being larger and brighter than others; some swifter, and drawing after them more persistent trains than others."†

Two well-marked groups—probably *rings*—of meteors,—several others more or less known—their nearest approach to the earth estimated at an average of sixty miles, and their ordinary velocity supposed to be somewhere about twenty miles in a second, hastened as they approach the earth's attraction to nearly forty miles—so much being granted, have we yet answered the question "what are they?" Are they solid or gaseous, are they large or small, perpetually luminous or only exceptionally so?

The late observations which have succeeded in subjecting their fleeting light to the process of spectrum analysis will probably clear up some of the difficulties respecting their nature.‡ But even before this clue was given for their investigation, the learned had arrived at the conclusion that all shooting stars are "assemblages of fragments, finer or

* *British Association Report*, 1865, p. 131. † Ibid, 1864, p. 101.

‡ See Mr. Alexander Herschel's paper on the *Prismatic Spectra of the August Meteors*, 1866, INTELLECTUAL OBSERVER, October, 1866.

coarser," that they are *not* luminous as they travel through space: but that as they near the earth, the friction of our atmosphere ignites them, and they are entirely consumed in a few moments. This description applies to meteors such as we see in general, and during the periodic displays; but occasionally we encounter bodies of greater density, which cannot be so readily consumed, sometimes entire, and at other times in a fragmentary condition. Samples of such meteors are to be found in various mineralogical collections.

The subject of these metallic stones which have really "fallen from the sky" is most curious, but must not be pursued here; we have made a sufficiently long digression from our fourth question, "What grounds were there for supposing that a more splendid display of meteors than usual would be seen in 1866?" To answer this, I revert to the INTELLECTUAL OBSERVER for August, 1866. It contains (p. 39) extracts from a lecture given at the Royal Institution, by Mr. Alexander Herschel, *On the Shooting Stars of the years* 1865-66, *and on the probability of the Cosmical Theory of their origin.*

The lecturer stated that Professor H. A. Newton, of Yale College, U.S., had calculated that in the current year, 1866, a prodigious flight of meteors, the most imposing of its kind, and visible over a large area of the earth's surface would make its appearance—perhaps for the last time in the present century—on the morning of the 14th of November. Professor Newton had searched in ancient records, and observed that between the 12th of October (O.S.) and the 13th of November (N.S.), during the years from A.D. 902 to 1833, not less than thirteen great star-showers have been recorded. When he had made the requisite corrections for the change of the earth's position, astronomically known as the precession of the equinoxes, he was able to compare the dates with exactness,* and became convinced of the fact that there are periodical re-appearances of the November-shower in extra grandeur, at intervals separated from each other by nearly the third part of a century, or by some multiple of this period. This shower was observed from Cumana in South America by Humboldt and his companion Bonpland, on the morning of November 12th, 1799, and was a spectacle of extraordinary grandeur. Nothing comparable to it appeared till the morning of the 13th of November, 1833, when another magnificent display was seen in the United States of America.

Professor Newton proposed the following theory to account for these returns of the phenomenon, that there is a *condensed*

* See *British Association Report*, 1863, p. 325.

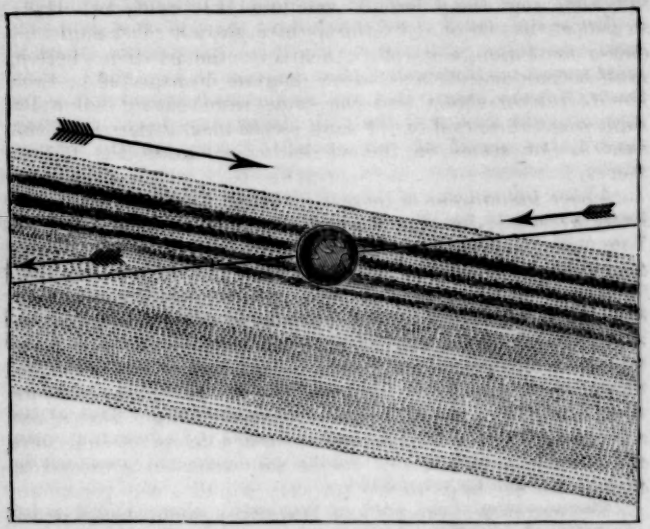
part in the November ring of meteors,—which I have ventured to call the *jewel* of the ring,—and that each meteor in the whole ring, and in this condensed part or *cloud*, moves in a nearly circular orbit round the sun in a period which may be about eleven days less than that of the earth. The earth (for example) encountered the densest portion of this cloud in November, 1833; but the next year this portion passed eleven days before the earth returned to that point of its orbit; the following year the difference amounted to twenty-two days; so that at the end of about thirty-three years it must gain one entire revolution, and return nearly to the position where it must encounter the earth. (See diagram on page 452.) Professor Newton shows that the same result would follow by supposing the period of the ring eleven days *longer* than the earth's, but seems on the whole to incline to the former theory.

I have taken some of these explanatory details from a letter lately written to the *New York Times* by Professor Loomis, of Yale College; also from the *American Journal of Science*, as quoted in the *British Association Report* for 1864, p. 96, containing Professor Newton's data and theories as given by himself. In referring to past recurrences of the phenomenon, he remarks that, "a want of punctuality of one, two, or even three years in the return of the display may be accounted for by the revolution of the earth on its axis, by which observers were deprived of a view of the spectacle during a part of its existence;" but ends his communication by predicting with considerable confidence, a "maximum display on the morning of the 14th November, 1866."

The morning of the 14th of November came—and now let us make an essay in celestial perspective, and see what had happened. Let us divest our minds, if possible, of the idea of a canopy of sky-rockets, and "from the apparent configurations and movements of objects as seen projected on the imaginary concave of the heavens, conclude, so far as they can be thence concluded, their real geometrical relations to each other and to the spectator." What were the real bearings of the earth and the stream of meteors on that memorable morning when this "terrestrial ball" had been for some short time plunged in the current? Somewhat, I think, like this. Never mind, reader, if I have made the earth a little too large in proportion, or the stream too narrow, or too defined in outline. The inclination of the two paths is, or should be, 17°: the course of the meteors is retrograde, as stated by Professor Newton: and the shaded appearance of the stream is meant to indicate the sudden transitions of richness which occurred in the star-shower, causing the meteors to come at the rate some-

times of a hundred per minute, then only fifty, then a hundred, and so on.*

The reflection will probably occur to our readers, were the meteors really like that, a dark, formal stream? How much more beautiful was their actual aspect as seen by us! Truly it was so, as indicated by Mr. Herschel's heartfelt words, describing how they travelled to all parts of the sky "with a swift and stately motion most beautiful to behold, if not almost



IDEAL REPRESENTATION OF THE EARTH'S PASSAGE THROUGH THE STREAM OF METEORS.

too wonderful and too surprising to describe."† I was roused from sleep to look at them. My informant told me that an old railway porter had just said, "God has sent us fire-works to-night;" and I appreciated the remark when I saw them. My thoughts had, on that day, been unavoidably fixed on the concerns of this earthly ball, rather to the neglect of the affairs of space; and I shall long remember how much I was cheered and uplifted by the sight of the November meteors, and how I felt that they were indeed *given* by Him who gives us richly all things to enjoy.

I intended to have attempted a sort of *resumé* of the observations of others, but will leave the task to abler hands,

* The attempt to introduce this circumstance into my drawing was suggested to me by the Rev. F. Howlett, F.R.A.S.

† Letter to the *Times*, November 17, 1866.

and merely tell my own story of what I saw, copied from a narrative which I wrote on that morning before daybreak.* It will be seen how conspicuous was the fact of the meteors radiating from a point in Leo—a circumstance of which I had doubtless read in books, but had little or no recollection of it.

On the evening of the 13th, at eleven o'clock, I looked out from my house at Seapoint, near Dublin, to see whether anything unusual were occurring, and observed that all was still—Mars glowing near Castor and Pollux; Sirius calmly accompanying Orion. "Good night to the stars," thought I; but it was not to be so. At a few minutes after twelve, Dublin time (say 12·30, Greenwich time), I was called up with the information that the shooting stars were chasing each other with wonderful rapidity. I hastened to look at them, and the first idea suggested was indeed that of an exhibition of fireworks, but how much more beautiful they were! Their occurrence was almost incessant. From 12·40 to 1·30, and later,† it would have been difficult to find a moment in which none were visible in some part or other of the sky. Sometimes three or four fine ones could be seen at once.

There was a marked difference in their appearance as seen from a window facing the east, and from a bow window commanding a view of the north, west, and south; and I set myself to find out in what this difference consisted. I first viewed them attentively from the bow window; the shooting stars invariably moved *downwards* there. Each commenced with an outburst of brilliant white light, like *one* of the many stars of a rocket; and this bright star travelled a second or two, and then disappeared, not very rapidly, but remaining visible four or five seconds as a beautiful spindle-shaped track of white light, the general straightness of its form being very remarkable. These spindles tended almost perpendicularly downward in the west, downward from left to right in the south, and downward from right to left in the north. Sometimes a wonderfully bright star appeared, with a long, thread-like track of extraordinary length, nearly from the zenith to the horizon. The stars, or *nuclei*, of these meteors were generally white, but occasionally one appeared blue, or red, or bright yellow. My impression is, that in these cases the train or track of light was sometimes of a different colour from the star.

The shooting-stars in the *east* were in general smaller than those observed in the north, south, and west; but they soon riveted my attention even more than the others had done.

* Mr. Slack's spirited account of the display is already in the hands of my readers. See No. for last month. [The reader is requested to correct the date in Mr. Slack's paper to 13-14th. Ed.]

† Greenwich time, which will be henceforth used in this description.

For I presently perceived that *their* course was not invariably downward. I could see some move perpendicularly upward, some darting quite horizontally towards the left, some moving upward in a sloping course, and some also downward like those seen from the bow window. These latter, sloping downward, were those nearest to the north and to the south; and, having ascertained this, I soon observed that there was a point in the heavens from which they actually started in all directions—I do not mean at random, or crossing each other, but in an invariable course, like the railroads from a great city. The meteors *at that spot* (close to the position of the star γ in Leo) were not of very frequent occurrence, but I observed all the different directions described, probably in the course of ten minutes, during one part of the morning; and more than once I saw with great interest two shooting stars at the same moment moving away from this point at right angles to each other. Numerous meteors commenced at points quite distant from γ in Leo; but wherever they commenced they seemed to travel with regularity, as if from about that point.

With respect to the size of the meteors in the east, I am certain I saw none which were long or threadlike, anywhere near γ; at one time, on the contrary, I saw strangely small and even crooked ones near that spot.* They increased in magnitude as observed towards the north or south. Several fine ones passed above and across Orion, and always downward from left to right. Their *nuclei* were, in my opinion, much brighter than Sirius. Many meteors went *as if* over the house, like sky-rockets; and twice, meteors of extraordinary brightness came, lighting up the whole landscape, but I cannot give a description of their form, as in neither case had I happened to look in the right direction at the moment they appeared. These bright flashes occurred at about 1·45.

I saw one or two exceptions to the straight form in the long meteors. There was one decidedly crooked, or waved. Several of the meteors indeed were curved, as an effect of perspective, from their great length, if seen in the south or north. A few *nuclei* appeared without trains, merely showing a second or two as bright moving stars; but these were exceptions to the general rule.

Towards half-past two o'clock I began to notice that the phenomena were decreasing; at a quarter to three the meteors were rarely visible; and at half-past three they had almost entirely subsided. At 4·25 I remained on the watch for about ten minutes, and no meteors whatever were visible.

* Mr. Slack, it will be remembered, makes the following remark on similar meteors, "Probably their tails were behind them, and invisible from the foreshortening of perspective."

THE NOVEMBER METEOR-SHOWER AT GLASGOW.

BY A. S. HERSCHEL, B.A.

THE cloud-stratum of the second capital of Scotland affords coolness in summer and warmth in winter, and a protection from the unequal radiation of night and day. It would surprise persons unacquainted with the abnormally elevated temperature of climates on western coasts, to be informed that the mean temperature of Glasgow is three degrees warmer than the mean temperature of a place situated, like Birmingham, in the centre of the island; yet such, from the neighbourhood of warm streams of the Atlantic Ocean, is actually the case. The substantial advantage thus derived from the breezes of the sea has, however, its corresponding disadvantage of a more refined, aërial nature; for the watery vapours wafted with the wind do not always reveal at night, in the words of Byron—

> "—— in the sky that clear obscure
> So deeply dark, and darkly pure,
> Which follows the decline of day,
> Ere twilight melts beneath the moon away."

Fine nights, when they occur at this season of the year, are, however, unexceptionally good observing nights; and the morning of the 14th of November, 1866, when the predicted shower of the November meteors was expected to appear, was one of these, which might be reckoned among the most fortunate events of an observer's diary.

The skies were attentively watched to catch the first signs of their appearance, and many, like myself (among the number of four observers, consisting of Professor Grant and his assistants at the Glasgow Observatory), sat up, determined "for once in their lives" to make a night of it.

To witness the successful issue of an altogether novel kind of prediction was a small satisfaction, compared to the advantage which co-operation with Professor Grant afforded me in noting the particulars of the shower. The detailed description which Professor Grant published in the *Glasgow Herald* of the following day, shows his personal interest in the phenomenon, whilst his assistance enabled me to complete a set of observations which, alone, it would not have been possible to carry out.

A violent gale of wind blew from the 4th to the 8th of November; when the wind abated, and a fine double arch of the aurora was visible in the evening, about seven o'clock, spanning the north-west verge of the horizon. It resembled a cap-and-plume, the upper arch being only a fragment, which

joined the lower arch at its extremity close to the west point of the horizon.

Auroral glare in the north, but not so bright, was seen again at about ten o'clock on the evening of the 10th of November. Between three and five o'clock on the mornings of the 9th, 10th, 12th, and 13th, half-hour watches were kept up at intervals when the sky was clear, and the greatest number seen was six meteors in half an hour, on the morning of the 12th of November. These were the preliminaries of the display. From Professor Grant's description we learn that "The early part of the night of the 13th did not promise well—heavy rain and drenching showers alternating with clear views of the sky and the stars." And again, that "between midnight and one o'clock the sky on the whole was not favourable for observation, but occasional views of the heavens showed unmistakably that we were on the track of the meteoric shower, for the meteors were obviously shooting athwart the sky with increasing frequency." During this hour my share of the spectacle began.

At about midnight, an orange-coloured meteor, nearly as bright as Jupiter, shot overhead, with a slightly wavy motion, from Capella to near the head of Aries—a space of 45° or 50°—in about a second and a half of time; leaving a bright streak for a few seconds on its course. This was the first brilliant shot seen, and for the early hour of its appearance, when the phenomenon did not exceed an ordinary display on a fair 10th of August night, it was indeed startlingly bright. At a later stage of the night, when a few of the superlatively large meteors, or "ring-tail roarers" of the shower (to use an Americanism), made their appearance, and multitudes, unnumbered, of its compeers thronged the sky, it would not have arrested attention for a moment. Expectation was gradually raised, when, toward 12h. 30m. A.M., three meteors near together first appeared simultaneously, and drew the eye irresistibly to the locality in *Leo*, from whence they appeared to diverge, and whence a whole fleet of similar craft might shortly be expected to arise above the horizon, like argosies in full sail from foreign parts.

A cloud from the north-west now overspread the sky, and threatened us with showers of a different kind, likely, in fact, to leave us, at the end, but little wiser, and on the whole much wetter for our watch. It passed, however, quickly, and in the clear space which it left behind it, the next meteor was observed. At 12h. 33m. a meteor fully as bright as Venus shot in one second from the right hand of Andromeda to β Pegasi, leaving upon the first part of its course a bright train in separate links, which rapidly faded away. The remaining portion,

6° or 8° in length, continued visible four minutes, at first bowing itself, leech-like, and afterwards contracting itself into a globular nebula, which advanced southwards some 10° or 12° as far as *a* Andromedæ, where it disappeared. Its width, and ragged edges prevented any conclusion being drawn in the spectroscope regarding the nature of its spectrum.

Ten or fifteen meteors might now be counted by one observer in a minute. Flights of three meteors occasionally appeared together, and a powerful flash, like prolonged lightning at no great distance, drew our attention to every part of the horizon, in the vain attempt to see the residue of some large meteor.

At 12h. 41m. a dazzling object, two or three times as bright as Venus, passed in a second from midway between the "pointers" to the nose of the Lesser Bear, leaving a bright streak, divided like the last into two parts; but the first part in this case remained in sight the longest. The end-half afforded a decided spectrum, appearing as a single bright band in the spectroscope, no broader than if looked at through an ordinary piece of glass. It faded rapidly and disappeared, whilst the first half collected itself into a ball, and grew brighter, exactly as a row of gas-lights, seen one behind the other, look brighter than a single flame. In nine minutes it could no longer be traced, as it gradually vanished between the "pointers" at the place where the meteor first began.

The number of streaks now visible in the sky gave an opportunity for using the spectroscope. "Nov. 14th, 12h. 54m. A.M.; equal to Sirius; from β Canis Minoris to β Eridani. Left a streak for five seconds. The streak appeared as an extremely fine line in the spectroscope."

A more powerful spectroscope was now employed, consisting of the central portion, only, of a Herschel-Browning spectroscope, containing two prisms, and producing, therefore, twice the dispersion of a single prism. My assistant, Mr. Macgregor, looking at the streaks with the unassisted eye, whilst I watched the same streaks in the spectroscope, we each called out "gone," when the streaks appeared to us to vanish.

"12h. 56m. A.M.—Equal to a first magnitude star. Left a greenish blue streak for three to four seconds. We differed in our vanishing moments two-tenths of a second.

"12h. 57m. A.M.—Equal to a first magnitude star. Left a greenish blue streak for three to four seconds. We differed in our vanishing moments one-tenth of a second.

"1h. 0m. A.M.—Equal to Sirius. Left a greenish blue streak for four seconds. We spoke together."

The result shows that some of the streaks were composed of mono-chromatic light, altogether undimmed by its passage through the prisms.

The object of disposing of the radiant point at the early stage of the shower so as to leave the remainder of the night, and the principal part of the shower for the more important observations, put an end for the time to the experiments with the spectroscope, which it was intended to have renewed if the shower had not exhausted itself before a sufficient number of meteor tracks for the purpose of fixing the radiant point had been recorded. The shower increased in intensity until about ten minutes and twenty minutes past one o'clock, at which time fifty-six and fifty-seven meteors were counted by one observer, or almost exactly double the number counted at one o'clock, and at half-past one o'clock; the display then ceased as suddenly as it began; and an interval of three minutes occurred from 1h. 57m. 30s. to 2h. 0m. 31s., in which no meteor as bright as a second magnitude star (so far as my own tolerably open view of the sky extended) made its appearance. At 2h. 30m. the number counted by one observer was also very small, being only one per minute, and long before this time the "Great November shower of 1866" had obviously passed away, and was gone for ever from the field of calculation and prediction into the domain of history!

At 2h. 14m. A.M., a meteor, three times a bright as Jupiter, shot in the southern sky from between a and θ Geminorum to 2° above Aldebaran, leaving a streak, which like previous bright streaks was divided into two parts. The end-half, extending from iota Tauri to Aldebaran, curved itself northwards at the ends, and then collected itself into a knot, which drifted southwards to the three head stars of Orion, where it disappeared. The total period of visibility of this streak was five minutes.

Another meteor, which must have been a large fire-ball, but which the Observatory buildings unfortunately hid from our view, appeared at 2h. 41m. A.M. Shortly afterwards we perceived its streak, bent in the form, and with the appearance of a red hot horse-shoe suspended in the sky, between the stars ϵ, χ of the Great Bear. The open ends of this singular foot-print (for so it appeared) of the meteor gradually widened out for fifteen minutes, (during which the streak continued visible) and the apex of the shoe became pointed, and drew off towards the south. Just before disappearance the stars forming the square of Ursa Major appeared clipped by a gigantic calipers of which the point or hinge was at the stars ν ξ upon the Bear's hind-foot.

A number of matters yet remained to be decided regarding the white, yellow, and purple colours of the meteor-streaks, the prevailing yellow or orange colour of the heads, and other important characters of which the use of the spectroscope might

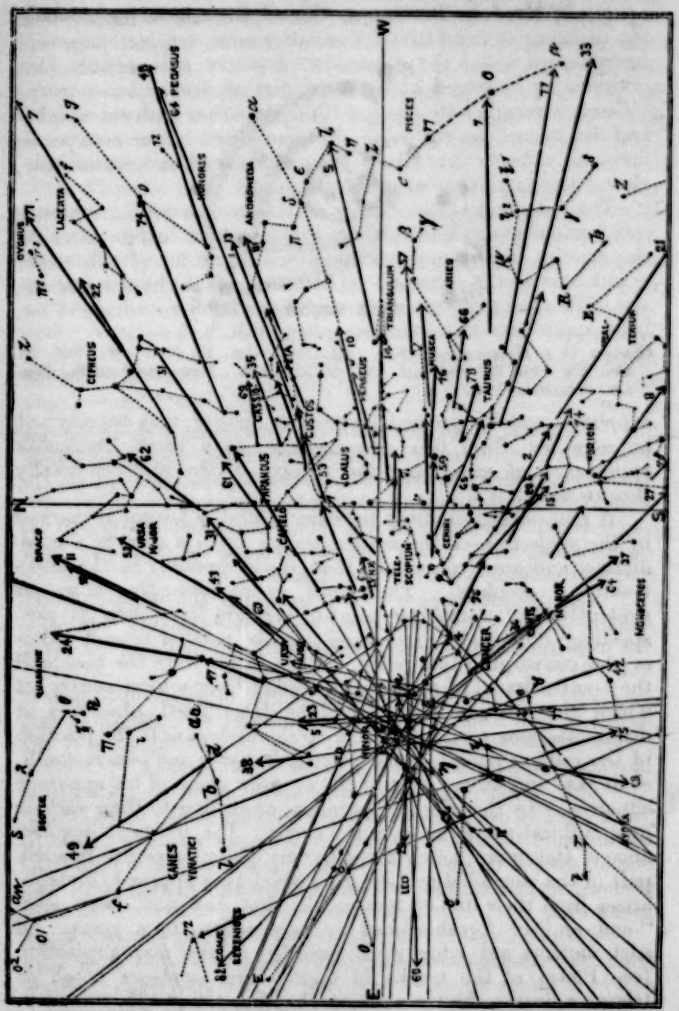
have offered some solution. The want of observations on these points, unavoidably left un-made by the cessation of the shower, a paper by Mr. John Browning, which follows, most opportunely

Changes of a Meteor-streak, Nov. 14th, 1866.—1st, 2h. 42m. A.M. 2nd, 2h. 44m. A.M. 3rd, 2h. 48m. A.M. 4th, 2h. 52m. A.M. Disappeared at 2h. 56m. A.M. Duration, 15m.

supplies; and the present November shower may happily not be regarded, from this circumstance, as a most invaluable opportunity of examining the spectra of the meteors totally thrown away.

A point about midway between γ and μ Leonis is marked by the projection of the meteor tracks upon a map, in a more distinct and positive manner than could possibly be the mere result of accident. The point so prominently shown is evidently the "vanishing point of straight lines seen in perspective" (Olmsted's expression), either parallel to each other or else converging to a point. If the latter were the case, and the bombardment of meteors proceeded from a local centre, of which the precise place could be determined, observers at distant stations would differ among themselves as to the position of the radiant point,—some placing it north and others south, some east and others west of the average place of its apparent situation,—by the effect of parallax, according to their various geographical positions upon the earth. The frequent appearance of stationary meteors at the very place, or centre in some part of the constellation Leo, from which they appear to diverge, arises from their line of motion, in that direction, been seen "end on," or foreshortened by perspective, to a point. Of such meteors not a few were recorded in the map projection (see Plate) of the tracks of eighty-three meteors noted at Glasgow during the time—from 1h. 15m. A.M., to 2h. 40m. A.M. —of the greatest intensity of the shower, and one such meteor was observed close to the position of the radiant point obtained from a complete *chevaux-de-frise* of meteor tracks taken from

TRACKS OF 83 SHOOTING STARS OBSERVED AT THE GLASGOW UNIVERSITY OBSERVATORY, 1866, Nov. 14th, 1h. 15m. A.M., to 2h. 40m. A.M., by A. S. Herschel and A. Macgregor, showing the position of the radiant point in R. A. 149°, N. Decl. 24.°



A. S. Herschel, del.—(NOTE.—A stationary meteor, shown thus ✲, was seen very near the radiant point.) For the sake of greater clearness our engraver has not given *the whole* of the intersecting lines shown in Mr. Herschel's large map, or in Mr. White's excellent photograph from it.

the surrounding regions, at all distances from the point of radiation of the shower.

For the use of directing a telescope towards its place on the morning of the 14th of November next, a future page will be taken up with a list of twelve places of the radiant-point obtained by observers at Glasgow, and at other places in the "Great November shower" of 1866; together with the heights and distances from the earth of some of the larger meteors so favourably observed at Glasgow in that shower, and, fortunately, also at the same time at other places.

The following is the extract of a letter, to which reference was made above. For this, as it contains valuable notes on the spectra of the meteoric bodies, the reader of the paper is indebted to the successful endeavours, which characterize the use of the spectroscope, in every observation to which it has been applied by Mr. John Browning, F.R.A.S.:—

"ON THE SPECTRA OF SOME OF THE METEORS OF THE NOVEMBER SHOWER IN 1866. BY JOHN BROWNING, F.R.A.S.

"On the night of the 13th of November, I chose for my place of observation the Observatory of Mr. Barnes at Upper Holloway, which is situated on the highest ground in the immediate neighbourhood of the observatory.

I began observing at 9h. 30m. P.M., and continued my observations until 4h. A.M., on the morning of the 14th. The spectra I obtained were of four kinds.

"1st. Continuous spectra; in which the whole of the colours of the spectrum, except violet, were visible. In even the most uniform of these, however, I am inclined to think that the yellow was strongly predominant.

"2nd. Those which gave a bright orange-yellow line of light; or only a faint continuous spectrum in addition to this yellow line. Such spectra have been clearly described in the INTELLECTUAL OBSERVER, Number for October, 1866.

"3rd. Those consisting apparently of only a single line of green light of nearly the same colour as that shown by *Thallium*. Of this kind I only obtained the spectra of two meteors. In one of these I thought I detected a trace of a very faint continuous spectrum, nearly obscured by the brilliancy of the green line.

"4th. The spectra of the trains. The light from green trains appeared continuous in the prisms. Those which were of a blue colour appeared as a line of lavender colour, with a still fainter trace of a continuous spectrum. In some few instances, no continuous spectrum could be detected."

The occurrence of bright green light in some of the nuclei, is a very remarkable result of these observations; pointing,

possibly, to the existence of *Thallium* in the meteoric bodies; as is also the existence of strong lavender light in some of the blue-coloured meteor-streaks occasionally without any continuous spectrum. The morning of the 14th of November next will present an opportunity for verifying the striking variety of colour so unexpectedly revealed by the spectroscope in the light; and hence also, probably, a corresponding diversity in the chemical composition of the November meteors.

Mr. Browning adds:—

"On account of the great difficulty which attends these observations, I cannot be at all positive of the accuracy of these results, except in the case of those which I have called the first class of meteor-spectra (*i. e.*, uniform continuous spectra of the nuclei).

"At about a quarter to two, a large meteor, of a greenish-yellow colour, shot from near Regulus through the belt of Orion. This meteor left a train of a steel-gray colour, which was visible for nearly three minutes, although the end of its path was partially obscured by fleecy clouds."

THE PLANET MARS.

BY RICHARD A. PROCTOR, B.A., F.R.A.S.

My object in the present paper is to exhibit to the readers of the Intellectual Observer the true relations under which the planet Mars will present himself at the opposition which takes place during January, 1867.

There is a marked variation in the circumstances under which Mars is seen at successive oppositions. The other superior planets vary chiefly as respects the altitude at which they cross the meridian (or culminate) while in or near opposition. Mars partakes of these changes*—in fact we shall presently see that they are exhibited in a somewhat exaggerated form in his case; but there are other and more marked

* A superior planet coming to opposition in midwinter attains an altitude about equal to the sun's midsummer altitude; near the equinoxes a planet in opposition has a mean altitude about equal to the sun's altitude at either equinox; and, lastly, a planet coming to opposition in midsummer attains an altitude only equalling the sun's altitude in midwinter. The reason is obvious—for the sun is always *on* the ecliptic, while the planets all travel *near* the ecliptic, and the ecliptic must be high by night when it is low by day, and *vice versa*. These changes produce a variation of 47° in the meridian altitude of a planet, a range of change which is yet further increased owing to the inclination of the planetary orbits to the ecliptic. The effect due to the last cause is small, however, except in the case of Mars.

variations presented by Mars, which the other superior planets do not exhibit, or at least not to any noteworthy extent. These peculiarities will be understood when we come to examine the nature of Mars' orbit.

The planetary orbits it is well known, are elliptical. But although several of these orbits differ very appreciably from circles *concentric with the sun*, yet their difference from the circular *form* is always very small indeed. For instance, the orbit of Mars, which is one of the most eccentric, yet differs so little from the circular form that if it were accurately traced down as an ellipse having a greater axis one foot in length, a circle described around this ellipse would nowhere separate from it by a distance exceeding one-eightieth part of an inch; though on the same scale, the distance of the sun from the centre of the ellipse would be represented by a length of more than half an inch (almost exactly ·56 of an inch). Again, the inclination of the planetary orbits to the ecliptic, though quite sufficient to make the absolute distances by which the planets may be separated from the plane of the ecliptic very considerable, is yet so small in itself, that a representation of the orbits *in plano* is not unsatisfactory—save only in the case of Mercury, and some of the minor planets. It appears, then, that circles traced on paper may be taken to represent approximately the orbits of planets, if only these circles are properly *centred*.

In Figs. 1 and 2, parts of the orbits of Mars and the earth are traced down as accurately as possible, on the scale of one-eighth of an inch to 4,000,000 miles. S is the position of the sun, C is the centre of the earth's orbit. C′ the centre of the orbit of Mars. The position of the earth at the time of winter-solstice is at W. Sol., while in Fig. 2, the position of the earth at the time of vernal equinox is at V. Eq. The two figures must be supposed to be parts of a single delineation of the orbits, the scale of which would be somewhat too large for our pages. The reader is recommended, however, to describe such circles on a larger sheet, taking the centering from Fig. 1. He will then be able to appreciate what is only partially indicated in Figs. 1 and 2, the remarkable variation in the distance separating the two orbits. He will find, indeed, that at the point of nearest approach (nearly in direction C′ S) the distance separating the orbits is little more than half the corresponding distance on the opposite side—that is, in direction S C′.

The orbit of the earth is supposed to lie in the plane of the paper, while the plane of Mars' orbit must be supposed to cut the plane of the paper, in the line S ☊ the part of the orbit which appears in our figures lying above the plane of the paper.

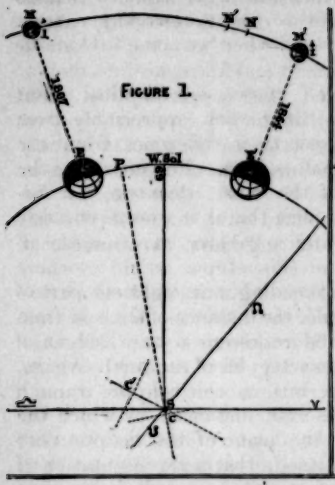


FIGURE 1.

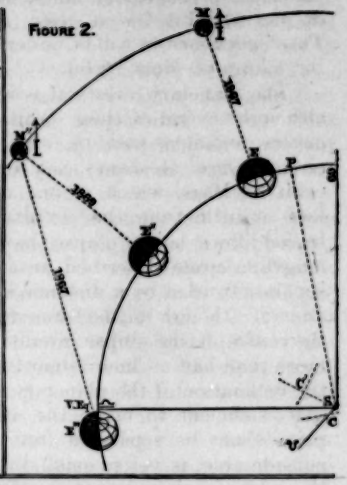


FIGURE 2.

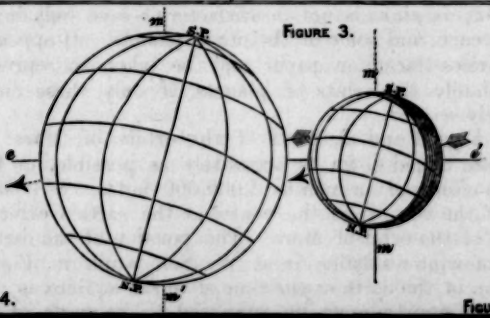


FIGURE 3.

FIGURE 4.

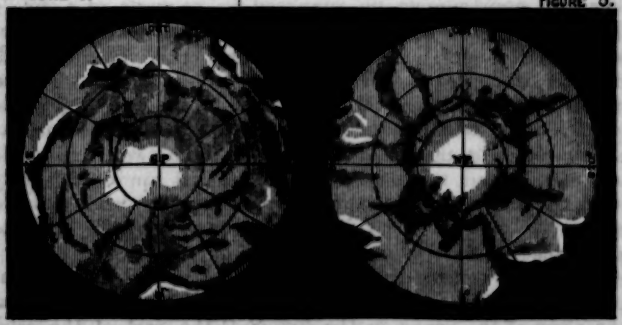


FIGURE 5.

The short lines surmounted by arrow-heads, represent the distance at which different parts of the orbit lie above the plane of the ecliptic.*

The figures representing the earth and Mars, are not drawn to scale, but purposely enlarged. The meridian lines upon them serve to indicate the position of the polar axes of the two planets. They are such that whereas the earth, when at V. Eq., has its polar axis square to the line from the sun, Mars is similarly circumstanced when near N or N′. The axis of the earth must be supposed to be inclined at an angle of 66½ degrees to the plane of the paper; that of Mars, at an angle of about 60 degrees.

The two planets move round their orbits in the same direction (E′ E E″ or M′ M M″) at different rates; the earth taking one year to complete her circuit, Mars taking 1 year 321¼ days to complete his. Thus if they start together, the earth will go twice round, while Mars has gone little more than once round; and *on an average* the earth will make up this small arc by which Mars is in advance, in 49¼ days. Thus the interval between successive oppositions is on an average 2 years 49¼ days. But the rate at which Mars travels is so variable, owing to the eccentricity of his orbit, that this interval of 49¼ days is sometimes largely exceeded, at other times as largely fallen short of. For Mars in perihelion travels nearly half as fast again as he does in aphelion: the earth also moves at a variable rate, though her variation is much less marked than that of Mars; it happens, further, that the earth is moving at a rate less than her mean rate, when opposite that part of Mars' orbit in which he travels fastest, and *vice versa*. Hence it is that the intervals between successive oppositions differ so noticeably, For example: in 1860, Mars came to opposition on the 17th of July; in 1862, he was in opposition on October 5th, 80 days later; in 1864, on December 1st, 56 days later; in 1867, he will come to opposition on January 10th, only 41 days later; in 1869, on February 13th, only 33 days later; and in 1871, a yet smaller number of days will separate the date of opposition from that of 1869.

A word or two as to the absolute dimensions of the two orbits. The mean distance of the earth from the sun, is 91,650,000 miles; her greatest and least distances 93,190,000 miles, and 90,110,000 miles, respectively; thus the eccentricity, or C S, is 1,540,000 miles. The mean distance of Mars from the sun, or the distance C′M, is 139,650,000 miles; his aphelion and perihelion distances being, respectively, 152,670,000, and

* Only the part of such lines between the two cross-lines is to be taken as representing this distance.

126,620,000 miles; his eccentricity, or C'S, is 13,025,000 miles. The rising node of the Martial orbit, is in longitude 48° 27′, measured from S ♈ in the direction of the planet's motion. Mars reaches his greatest distance from the ecliptic plane, near M″ (Fig. 2), when his distance from that plane is no less than 4,850,000 miles.

The point at which the two orbits approach nearest lies nearly in direction C'S, but somewhat *precedes* that direction, owing to the eccentricity of the earth's orbit. Here the orbits are separated only by 34,140,000 miles, whereas, in direction S C′, they are separated by no less than 61,860,000 miles. Hence the planet Mars appears much larger when he is in opposition near perihelion, than when he is in opposition near aphelion. He is also more brilliantly illuminated when in the former position. Hence, when in opposition near perihelion, he shines with a brilliancy comparable to that of Jupiter and Venus; and his appearance at such a time has caused alarm to the uneducated. In August, 1719, for instance, when he was only $2\frac{1}{2}°$ from perihelion, at the time of opposition, he created the same sort of panic that brilliant comets are apt to produce. His ruddy aspect, which gained for him among the Greeks the epithet ὁ πυρόεις, tended to increase this effect.

Since Mars, when he comes to opposition near perihelion, is south of the equinoctial, he attains but a moderate altitude on the meridian, and on this account he is less favourably seen. He is in fact thrown much further south at this time than he would be if he travelled in the plane of the ecliptic. For, although the plane in which he moves is inclined at an angle of only 1° 51′ 5″ to the plane of the ecliptic, yet, seen from the earth in opposition, when nearly at his greatest distance south of the ecliptic (which happens if he is in opposition near perihelion), he is thrown nearly $7\frac{1}{3}°$ south of the ecliptic. This will be clearly understood if we refer to Fig. 2 to exhibit the corresponding projection of Mars *north* of the ecliptic; for it will be very evident that Mars, being raised above the plane of the paper at M or M″, would appear much more elevated above that plane to an eye placed at or near the centre of E or E″, than he would to an eye placed at S. The greatest possible meridian altitude of Mars in our latitude is about 66°, his least scarcely exceeds 10°. Those who are in the habit of using the telescope will know very well what this means, and will readily understand that perihelion oppositions of Mars lose much of their superiority, through the comparatively low altitude of the planet on the meridian. Hence far better views of Mars were obtained in 1862 and 1864 than in 1860, though he was farther off slightly in 1862, and very considerably in 1864, than he had been in 1860. The approaching opposition is

exceedingly favourable as respects altitude; but the planet will be yet further removed from us than he was in 1864.

Some misapprehension, by the way, appears to prevail respecting the apparent diameter of Mars in 1867. We find it stated by some of our best authorities that the planet will appear larger than he did in 1864. This is a mistake, though the *Nautical Almanack* appears to countenance the supposition. In 1864, Mars came to opposition when situated as at M′ in Fig. 1, the earth being at E′; this was on December 1st, 1864. In 1867 Mars in opposition will be situated as at M, the earth being at E. If now the distance E M (measured of course from centre to centre) be measured, it will be found to exceed the distance E′M′ by more than one-seventh. I would not be understood as placing the accuracy of my figures against the calculations of the *Nautical Almanack* computers; though I I may note in passing that much more may be learned from carefully drawn diagrams than is commonly supposed.* As a matter of fact, however, the increased diameter given in the *Nautical Almanack* results from a change in the assumed value of the planet's actual diameter, and a reference to the columns in which the distance of Mars is noted will at once show that the planet is farther off, and therefore must present a smaller apparent diameter. The actual distance of the planet will be about 58,500,000 miles on January 10, 1867, against less than 50,000,000 miles on December 1st, 1864. At the opposition of February 13, 1869 (see Fig. 2), Mars will be yet further off than in 1867. In fact the next three or four oppositions will be very unfavourable ones as respects the distance of Mars, and will be successively less and less favourable as respects his meridian altitude. At the approaching opposition the planet will attain an altitude of 64½° when in opposition.

But, if we would rightly understand the physical peculi-

* It seems to me that most works on popular astronomy fail in this respect; it is as easy, or nearly so, to give diagrams correctly representing the relations to be illustrated, as to give incorrect drawings, and it is surely far more instructive. The mind apprehends much more readily, and retains much more certainly, what is presented to the eye, than what is stated verbally. Many of the most marked features of the solar system, or of astronomy generally, admit, too, of being fairly exhibited in diagrams. Occasionally, indeed, it becomes necessary to exaggerate dimensions; in such a case it is sufficient to call the attention of the reader to the want of proportion in the drawing. But often (almost always, in fact) incorrect drawing is admitted where the just proportions could be easily presented. Take, for instance, the eccentricity of Mars' orbit. In Guillemin's *Heavens* we find a figure representing the orbits of the earth and Mars, in which no attempt whatever is made to exhibit this feature, though it is one of the most remarkable and most easily illustrated in the solar system.

Singularly enough, in the Bridgewater Treatises, Whewell remarks that all readers of works on popular astronomy are familiar with the appearance of the solar system, represented as it is in such works by a number of slightly eccentric ellipses. Where are we to find such works?

arities presented by this interesting planet—the only one whose true surface we are able to examine satisfactorily—we are not to content ourselves with observing him in this or that position among the signs. For then we should only know of his appearance at this or that Martial season. We must examine him at every opposition, and endeavour, if possible, to connect the appearances presented at different oppositions with the seasonal changes which may fairly be assumed to be taking place upon his surface.

The seasons on Mars are due to an axial inclination not differing greatly from that of our own earth. From a series of observations by Sir W. Herschel it would appear to follow that the point of Mars' orbit corresponding to our vernal equinox (northern hemisphere) is at present in longitude 78°,—N in Fig. 1. He made the inclination of the axis to the plane of Mars' orbit 28° 42′, to the plane of the elliptic 30° 33′. The determination of these elements is not a problem which we can expect to have exactly solved. Accordingly, we find that Dr. Oudemans, applying observations taken in 1830—1837 by Bessel, with the Königsberg heliometer, obtained results differing appreciably from Herschel's. He assigns an inclination $1\frac{1}{2}°$ less than that given by Herschel, and he places the Martial vernal equinox as at N′, Fig. 1. We learn also that this determination does not correspond quite accurately with some pictures of Mars taken by good observers.*

Fig. 3 indicates the polar presentation of Mars (supposed to be seen in an inverting telescope) at opposition, on Dr. Oudemans' assumption as to the inclination of the axis. The arrow represents the direction in which the planet is actually moving, while *m m′* represents a declination-circle through his centre, and *e e′* a declination-parallel, so that the apparent motion of Mars across the field of the telescope will take place in direction *e′e*. The polar presentation will gradually diminish as the planet retrogrades (that is, until the middle of February), and then gradually increase. In the beginning of April, when Mars has nearly reached his maximum phase of gibbosity, he will appear as shown at Fig. 3. At this time he will nearly have reached the summer-solstice of his northern hemisphere, so that the southern polar snows may be expected to be much more extensive than they had been three months before. The planet will, of course, appear much smaller his distance being so much greater—see in Fig. 2 the longer line marked 1867.

* It appears to me that the two pictures by De la Rue, reproduced in Guillemin's *Heavens*, require a somewhat larger inclination than that assigned by Dr. Oudemans.

Figs. 4 and 5 represent the features of land, water, snow-caps, etc., which have been seen by Dawes, De la Rue, Lockyer, Phillips, and others of our best observers on the southern and northern hemispheres of Mars, respectively. It need hardly be said that Mars never presents either pole *directly* towards the earth: nor, if he did, would he appear as in Figs. 4 and 5. These must be looked upon as *maps*, and they are intended to enable the student to fill in tracings or copies of Fig. 3 with suitable details—the upper half (or rather the part above the equator) from Fig. 4, the other part from Fig. 5; the bounding circles in Figs. 4 and 5 representing the Martial equator. When this is carefully done, the student will recognize the well-known features given in works on popular astronomy; and the observer, having made several such maps corresponding to different stages of rotation, will be able to interpret or correct the results of his own telescopic observations of the planet during the first three months of 1867.

PROGRESS OF INVENTION.

Economic Production of Aniline.—The importance of aniline and its derivatives, in a commercial point of view, has become so great, that any improvement which tends to facilitate its production is of great value. It is obtained, as our readers are aware, by means of benzine, which hitherto has been procured only by a somewhat complicated process. M. Bobœf has been able greatly to simplify this. He dissolves the heavy oils contained in coal-tar with soda, at ordinary temperatures. They are thus separated from the benzine, which floats on the surface, and may be obtained quite pure by mere decantation and rectification. The residue, after decantation, is a product of some value. It is a combination of coal-tar and alkali, which constitutes a kind of soap, and has been termed by M. Bobœf phenate of soda. He considers that it possesses all the useful properties of phenic acid.

Delicate Test for Acids.—Hitherto blue litmus paper has been the most sensitive test possessed by the chemists for the presence of an acid. Unfortunately, however, it has been found that its not being reddened by a given fluid affords no absolute certainty of the absence of acids. It is even inferior in delicacy to the reddened litmus paper used as a test for alkalies. M. Schönbein has, however, furnished us with a test for acids of remarkable sensitiveness. It indicates the presence of the very smallest amount of an acid, being so delicate that it shows the presence of carbonic acid in distilled water that has been merely breathed upon. It is obtained in treating cyanine blue with soda; dissolving one part of the product in one hundred parts alcohol, and adding twice its volume of water to the solution. The cyanine blue is formed by

acting on iodide of amyl with lepidine. Schönbein's test fluid is applicable also to the detection of bases, and is of extraordinary delicacy when used to that purpose, enabling us to ascertain the presence of the exceedingly small amount of oxide of lead, which is dissolved by water, and which is not to be rendered perceptible by sulphuretted hydrogen. That used for acids is adapted to alkalies by merely reddening it with an acid.

Propulsion of Boats on Canals.—Great as has been the extension of the railway system, and numerous as are the advantages it possesses over every other mode of conveyance, canals, at least those already constructed, would retain a large portion of their utility, and of their superiority, in point of economy, could steam be employed generally upon them. But such has not been found the case, notwithstanding the many efforts which have been made for the purpose. The great disturbance caused in the water, not only by every form and application of paddle-wheel, but also by every adaptation of the screw propeller, causes a ruinous effect on the banks. A trial is, however, being made in France of a mode of using the paddle-wheel, which is found to be free from objections of this kind, and which will, if not accompanied by others peculiar to itself, most probably give a new impulse to canal navigation. Only one paddle-wheel is used, and it works in the centre of the boat, in a space which is enclosed on all sides, except at the bottom. The lowermost paddles project below the keel, and are so effective as to produce, it is said, a velocity equal to that obtained with any other arrangement that has been tried.

Simple Mode of rendering Resins Soluble.—Certain resins, such as Calcutta copal, are not, in ordinary circumstances, soluble in spirits of turpentine, benzine, petroleum, and other hydrocarbons; but they are rendered so by the application of heat. This, however, is objectionable, among other reasons, from the loss of one-fourth of the weight which occurs. It has been found by M. Violette that this loss may be avoided by heating the resins in close and strong vessels to a temperature between 350° and 400° Cent., and after this cooling them. They are then soluble, even at ordinary temperatures, in the above-mentioned fluids, forming excellent varnishes, which may be used for even the most delicate purposes. They undergo no loss of weight, and the effect produced on them is due to the conjoined action of both heat and pressure. There is one circumstance, however, which, at first, may be a source of difficulty, when the manufacture is carried on upon the large scale. The vessel in which the resin is heated must be able to support a pressure of about twenty atmospheres. The resin may be heated, and the varnish made by a single process. For this purpose it is only necessary to heat to the required temperature a mixture consisting of one part by weight boiled linseed oil, four parts spirits of turpentine, and one part Calcutta copal.

Precipitation of Metals from their Solutions by Magnesium.—Magnesium, for a long period after its discovery, remained a mere chemical curiosity. It was then applied to the production of a light, suitable not only for ordinary illumination, but, which is of far

more importance, to the purposes of the photographer; and in such a way as that, to him, the day was practically rendered twenty-four hours long, and the darkest cavern became as well adapted to his art as the most brilliantly lighted studio. A new, and scarcely less important use of magnesium has now been discovered. It is found to precipitate metals from their solutions, and in such circumstances as to afford valuable aid to the toxicologist in medico-legal investigations regarding cases of supposed poisoning. Sometimes it gives rise to precipitation in the metallic state. Thus it throws down iron and zinc from slightly acidulated solutions of their proto or sesqui salts; and cobalt from a similar solution of its protoxide. In these, and other cases, a very remarkable circumstance occurs—hydrogen is evolved. The evolution of this gas, however, prevents arsenic, or antimony, from being precipitated in the metallic state; since each of these metals combines with the hydrogen, and passes off with it. The iron, zinc, and cobalt thus precipitated assume a brilliant metallic appearance if they are well-washed, and then compressed—a very slight pressure being sufficient with the zinc. Iron, cobalt, and nickel obtained in this way are highly magnetic. These are not the only metals which are thrown down by magnesium. It precipitates also gold, silver, platinum, bismuth, tin, mercury, copper, lead, cadmium, and thallium. Other important circumstances are the consequence of the great solubility of magnesium. Thus it decomposes water with great rapidity, if a very small quantity of chloride of sodium or sal ammoniac is present; and the hydrogen thus evolved when the magnesium contains no silicium, is quite pure. The great tendency of magnesium to become oxidized also renders it highly effective as a battery element. If a plate of magnesium, only 0·1 gramme in weight, is immersed, with a very small plate of copper, in a glass tube which has a capacity of six cubic centimetres, and is filled with water which has been acidulated, a galvanic current will be produced that will suffice to keep a small electro-magnetic apparatus, or to afford with a Geissler tube an illumination ten centimetres in length for about ten minutes.

New Application of Colloid Diaphragms.—A mode of dialysing gases by means of colloid diaphragms has recently been discovered. It has long been known that even a thin pellicle of caoutchouc is totally impervious to gases, as such. But it has been found that it is capable of liquifying certain gases, which then pass through it, and are again restored to the gaseous form, or reaching the other side of the pellicle. Atmospheric air is one of these gases; but its constituents are not transmitted with a velocity proportioned to their relative amounts; the whole of its oxygen, but only half of its nitrogen is allowed to pass through. We are thus enabled to obtain oxygen sufficiently pure to rekindle incandescent wood. To render the pellicle as effective as possible, the air to be dialysed must have free access to one side of it, and a partial vacuum must be maintained at the other. Colloid membranes are not the only simple means of liquifying gases. Platinum, palladium, and iron condense hydrogen into a liquid which, possibly,

is metallic. Palladium is especially effective in this way. And iron absorbs carbonic acid in still larger quantities than hydrogen—a circumstance which seems to explain certain facts connected with the manufacture of steel. These metals have no effect whatever on either oxygen or nitrogen. The necessity for the liquifaction of gases, previous to their passage through caoutchouc, is due to certain peculiarities of that substance. Though it refuses to transmit gases as such, it is very pervious to fluid. It will absorb water to such an extent, as to become opaque; and its pores are so much opened by this fluid, that the latter will pass through, and be evaporated at the other side. The pores, indeed, are visible under the microscope.

Projectiles affected by the Earth's Rotation.—The discovery of the effect of the earth's rotation on the path of a projectile is not new; but the practical consideration of it has only recently engaged attention. The flight of projectiles, from their imperfection, and that of the fire-arms then in use, was formerly so uncertain, that the small deviation produced by the rotation of the earth was considered unworthy of any attention. Such is not the case at present; and hence the subject has been of late carefully studied. The deviation depends on the latitude: being greatest at the poles, and zero at the equator. In our latitude a shell, about twelve inches in diameter, with a range of four thousand yards, would deviate to the extent of eight yards. The direction of deviation is different in the different hemispheres; in ours it is, whatever the azimuth of the vertical plane in which the path of the projectile lies, always to the right. A deviation is caused also by the rifling; and as this depends on the direction of the latter, it may, according to circumstances, either augment, or, to a greater or less extent, diminish that caused by the rotation of the earth. In our latitude, with a Whitworth gun, half the deviation arises from the earth's rotation; a proper system of rifling would therefore prevent any deviation whatever. But it must not be forgotten that a rifle without any deviation in one hemisphere would have a very considerable one in the other: as it would become equal to the sum of the deviations caused by both the rifling and by the earth's rotation.

LITERARY NOTICES.

Benedicite; or, the Song of the Three Children. Being illustrations of the Power, Wisdom, and Goodness of God, as manifested in his Works. By G. Chaplin Child, M.D. In two Volumes. (Murray.)—The canticle known as the "Benedicite," and commencing "Oh all ye works of the Lord, bless ye the Lord: praise him and magnify him for ever," supplies Dr. Chaplin Child with a series of texts on which he has written elegant little dissertations of a scientific character. The book is beautifully got up,

with good print, pleasant cream-coloured paper, well-designed headings, and tail-pieces to the chapters. The verses of the "Benedicite" carry the doctor through a wide range of subjects, from astronomy to natural history. Dr. Chaplin is strictly orthodox—more so than is common with scientific men—but his pages are free from anything like cant, and they will be welcomed in many families which more elaborate treatises would not reach. The "Benedicite" is a very favourite hymn, both on account of its literary merit, and from its adaptability to music, and it is certainly desirable that those who use it for the expression of their devotional feelings should have some idea of the way in which "all the works of the Lord do praise Him," in the thoughts which they excite in intelligent minds.

THE ORIGIN OF SPECIES BY MEANS OF NATURAL SELECTION; or the Preservation of Favoured Races in the Struggle for Life. By CHARLES DARWIN, M.A., F.R.S., etc. Fourth edition, with additions and corrections. Eighth thousand. (Murray.)—No book of modern times has contributed so much to philosophical thinking on the subject of natural history as the *Origin of Species* of Charles Darwin. A considerable allowance of abuse from those whose minds were ossified with old-established prejudice, did more to call attention to this masterly work than to obstruct the reception of the truths which it conveys, and if its author has to complain of some ill-treatment on the part of those who know no better, he has the satisfaction of being more or less supported by the greatest thinkers of the day. Gross mistakes have been often made in treating the doctrine of "natural selection" as if it were merely a hypothesis capable of being entirely overthrown; whereas the exposition of the doctrine is simply a statement of facts; and the scientific doubt pertaining to it, concerns the extent of its action, and not the question of its existence. That living beings succeed in hereditary series is one fact; that progeny are subject to variations from the parent type is another fact; and it is a third fact that some of these variations are transmissible in long succession. Man, by careful breeding, transmits peculiarities in horses, dogs, cattle, pigeons, etc., according to his wants, or according to his whims. In nature, the permanence, or long duration of a transmissible peculiarity must, as Darwin shows, depend upon its adaptability to the circumstances in which the modified creature finds itself. If it lessens the power of the individual to fight the battle of life, it dies out, while if it assists in that conflict, it remains. The hypothetical part of Darwinism consists in the inferences which he draws, or suggests, as to the *extent* to which these causes have operated in past times. If we suppose their extent of action to be no greater than we can *prove* it to have been, it will not account for the descent of a vast multitude of divergent forms from one, or from a few parent forms; but if the positive evidence in this matter is incomplete, the negative evidence is palpably afflicted with the same defect to an enormous degree. If we had cause to suppose that geology and palæontology displayed to us a fair and unbroken sequence of organic beings from early times to our own, the negative evidence against the hypothesis would be

very strong indeed; but an immense deal has been done of late years, not only to show beyond all doubt that our palæontological record is incomplete; but that it is imperfect to such an extent that it may be likened to a book from which whole chapters of unknown size, and unknown contents, have been cut out. How many of these chapters we may be able to recover no one can guess, as only a small part of the earth has yet been subjected to accurate examination. We are likewise profoundly ignorant of the physiological causes of hereditary transmission, with or without variation. Darwinism, therefore, stands in the position of an array of facts, proving the operation of certain principles, but leaving room for conjecture as to the extent of that operation, and its consequent capacity of evolving new forms. Whether, therefore, it be accepted or rejected, the mind should still have its "philosophic doubt," and avoid bigotry with its antagonism to reason, on either one side or the other. As for the religious questions which have been mixed up with this, as with all former innovations upon received modes of thought, they must be subordinated to the love of truth, and to the conviction that whatever method it may have pleased the Creator to adopt in peopling his world, that method must necessarily be one which, when understood, will excite the love and admiration of his rational subjects. The testimony of all science is conclusive as to the infinitely small proportion of nature which we can either observe or understand; but there is much to lead us to believe that all parts of the vast whole are bound together by a unity of design, as well as by a unity of origin from one ultimate source of intelligence and power. From the vastness of the *Cosmos*, human speculation is necessarily imperfect, from insufficiency of information, or from the complexity of the system baffling men's powers of analysis. The readers of Darwin will find many beautiful and amazing instances of the interdependence of objects that might have been supposed disconnected; and no one in whom the religious spirit is active can rise from a perusal of his pages without higher conceptions of the evidence which Natural Theology offers to the mind.

An Elementary Treatise on Heat. By Balfour Stewart, LL.D., F.R.S., Superintendent of the Kew Observatory, Examiner at the Universities of Edinburgh and London. (Oxford: At the Clarendon Press, MDCCCLXVI.)—This is by far the most compendious and well-arranged treatise on heat which we have seen, and the best adapted for class-teaching, or private study. It contains an immense amount of well-arranged information, and a clear exposition of the most recent theories and facts pertaining to its subject.

An Easy Introduction to the Higher Treatises of the Conic Sections. By the Rev. John Hunter, M.A. (Longmans.)—This little book, as the author tells us, has resulted from practical experience of the difficulties pupils feel in the study of conic sections, and we have no doubt it will be found of much use to the class of students for whom it is intended.

NOTES AND MEMORANDA.

NORMAN LOCKYER ON THE SPECTRA OF SUN SPOTS.—The *Proceedings of the Royal Society*, No. 87, contain an account of experiments by Mr. Norman Lockyer to test the opposing theories of Faye, and De La Rue, Balfour, Stewart, and Loewy. The former regards the interior of the sun as a nebulous mass of feeble radiating power at a temperature of dissociation, and the photosphere as of high radiating power, lower temperature, and chemical action. A sun spot he supposes to be an exhibition of the interior mass through rents in the photosphere made by ascending currents. The latter refer sun spots to a downward current of the cooler atmosphere, producing condensation and absorption in the photosphere. Mr. Lockyer in an experiment, which he hopes to repeat on a larger spot, did not find the spectra of the umbra give the character required by M. Faye's hypothesis.

MAXIMUM PERIOD OF NOVEMBER METEORS.—M. Coulvier-Gravier gives a diagram in *Comptes Rendus*, showing the proportions of meteors seen on the 12th and 13th November, from 1830 to 1866. The maximum was in 1833, the minimum in 1860, and he expects the next maximum to be in 1867, which would be in accordance with the prediction of Olbers. He says that, unfortunately, there will be a full moon at the time. There has been, he states, a progressive augmentation from 1862 to 1866, and he expects this will continue and culminate in 1867.

DISENGAGEMENTS OF GASES FROM THEIR SUPERSATURATED SOLUTIONS.—M. Grenez has a paper in *Comptes Rendus*, No. 21, on this subject. Solutions of gases in liquids are made under certain pressures, and the temperature of the fluid is then raised, and if, as is usually the case, the gas is less soluble in a warm fluid than in a cooler one, it will remain for a time supersaturated. If any rod of solid matter is then introduced, it becomes covered with gas bubbles, which escape freely if the liquid is stirred by the rod. After a time the immersed part of the rod loses the power of promoting the formation of gas bubbles; heat will also destroy this power, and solid bodies which have not been in contact with air do not possess it, and it is the air, or gas, adhering to the solid body which excites the action.

POISON IN WHALE FISHING.—In *Comptes Rendus*, No. 22, will be found an account by M. Thiercelin of the employment of small explosive shells to shoot whales, and kill them by conveying strychnine and curare poison into their systems. He states that a mixture in powder of soluble salts of strychnine, with one-twentieth of curare, will kill any animal if discharged into a wound. The animals require a five-thousandth of a gramme of the poison to each kilogramme of their bulk, or less if they are extremely large. He estimates whales to weigh, according to the sort, from 50,000 to 90,000 kilogrammes, and he mentions several instances of whales killed in a few minutes by his poison shells. The animals exhibit symptoms of tetanus, followed by death.

THE ICONOSCOPE.—M. Javal describes in *Comptes Rendus* the above named instrument as taking its place between Wheatstone's pseudoscope and the telestereoscope of Helmholtz. He says, by an optical combination identical with that employed in the binocular microscope of Nachtet, and the binocular opthalmoscope of Giraud-Teulon, the two eyes cease to receive different images of external objects. It results that if, under these conditions, a large picture is examined, the eyes preserve the same state of convergence towards whichever part of the canvas they are directed, and the spectator having no means of assuring himself concerning the plain form of the surface he examines, it assumes an appearance of relief in proportion to the time it is observed.

YEAST OF BEER.—M. Herman Hoffman states (*Comptus Rendus*) that if a little beer yeast is placed in a weak solution of honey that has been boiled, bubbles of carbonic acid rise for a few days from the liquid, but not directly from the yeast cells; after which the acid which is developed stops the fermentation. A pellicle of yeast cells and baciliform cells, frequently in chains composed of several

members (? bacteriums), this pellicle fructifies in the form of *Penicillium*. Many yeast cells fall to the bottom, and they can be made to fructify as *Mucor* or *Penicillium*, if placed on pieces of potato. Heating the liquid to 60° or 74° (C.) arrests the fermentation for some days, after which it takes place feebly, and many of the cells fructify in the bacillar form. After exposure to a still higher temperature the yeast loses its faculty of inducing fermentation, but can still produce a pellicle. 84° (C.) destroys its vitality altogether, unless it is heated in a dry state, when it can survive a temperature not exceeding 150°, and still produce a feeble fermentation. At 215° it loses this property, but still produces the pellicle. Similar results followed the application of creosote, chloroform and sulphuric acid in appropriate doses.

A New Glow-worm, with two Fires, has been found in the Grand Chaco, Argentine Republic. Wm. Perkins, Esq., F.R.G.S., writes from Rosario, October 20, 1866, to Wm. Bollaert, Esq., F.R.G.S. :—"I think I have made a discovery in natural history, and which you may make known to the scientific world. I found the female of the most extraordinary *Elateride* ever heard of, at least that I know off. It is a most brilliant glow-worm, one inch and a half long, with two fires. The body emits a most vivid flame of the ordinary greenish phosphorescent colour, while the head presents the appearance of a bright glowing *red* coal of fire. The reflection on a piece of paper is also of the two colours. I never saw anything so beautiful." Mr. Bollaert adds : "This is doubtless one of the *Cocuyos* family. One, the *Pyrophorus noctilucus*, is described as the South American *Cocuyo*, or glow-worm. Mr. Bollaert has noticed glow-worms in the West Indies, North and South America, but never in such abundance and beauty as in the wilds of Western Texas, still he never observed but the one light, the green."

Geology of the Paraná.—Mr. Perkins writes also to Mr. Bollaert: "You know how completely alluvial is all the littoral to the west of the Paraná. From Santá Fé up to the Bermejo, the right side of the Paraná is bordered to a strip of low alluvial land from two to five leagues in breadth. Then come the high *barrancos* of the Chaco, also alluvial, not a stone to be found from Rosario to the Bermejo; no clay neither. Well, I found, running in a direction S.E. and N.W. across the low lands mentioned, a large formation of conglomerate of agates and red clay, the latter of a brilliant colour, soft and homogeneous. The formation, where I found it, crossed the San Javier river, in latitude 29° 11′ S. At the town of San Javier, where the river of the same name approaches, the high banks (80 feet high) of the lowlands, I found, at the depth of 90 feet, a bright red coarse sand that was going through the process of hardening into stone. I also found large numbers of old oyster shells, with very brilliant colouring inside. They seemed to me so similar to the pearl oysters I have seen at Paraná and the Gulf of Guaymas, that I made minute inquiries of some old Indians in the town of San Javier. They said that *little stones* had been found in the shells in former times. I had to take the information for what it was worth. The wonderful shell formation at Paraná, where we found them in the gradations from a perfect shell to a finished formation of fine limestone, does not leave us any room for surprise at finding them a couple of degrees further north."

μ^2 Bootis and ζ Aquarii, Secchi's Measures.—Our attention has been called to the probability that the distance of the first of these stars as lately given by Secchi is too much. Mr. Webb finds it easier to divide than γ^2 Andromedæ, which he ascribes to the size of the disks. In 1864, Mr. Knott's measure of μ^2 Bootis was 0″·5; and in 1865, Mr. Dawes made it 0″·48. We are asked, but cannot tell, what Secchi means by the note he makes against this star, "*Non è ben certo, qual sia delle due pare* ⧖ 1938." Mr. Knott thinks there may be a misprint in Secchi's position of ζ Aquarii, which he makes 347°·83. Mr. Knott finds it 337°·01 D. 3″·644.

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